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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Accessories for Enhancement of the Semi-Automatic Welding Processes

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
Halter Marine Group, Inc.

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Accessories for Enhancment of the Semi-Automatic Welding Processes

Submitted to: SP-7 Technology Panel - Welding
National Shipbuilding Research Program

Prepared by: Newport News Shipbuilding

Final Report

Project Task 7-96-6
Contract No. P794-200
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for

"Accessories for Enhancement of Semi-Automatic Welding Processes"

to

National Shipbuilding Research Program
SP-7 Technology Panel - Welding

December 12, 2000

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Notice

1.0 OBJECTIVE

The project's objective is to identify specific areas of the semi-automatic welding operation that is performed with the major semi-automatic processes, which would be more productive if a suitable mechanical or electrical accessory was available. Ideas were solicited and concepts proposed for accessories that would suit the identified applications when performing GMAW, FCAW, and GTAW processes. Interested manufacturers would work to develop and evaluate prototypes suitable for production shipbuilding environments. The development of these accessories for work normally performed by the semi-automatic welding operator should significantly reduce operator hand-to-eye coordination requirements thereby enhancing their performance, increasing productivity, improving weld quality and reducing operator fatigue. Additional benefits should include reducing the incidence of welding related industry injuries (i.e. carpal tunnel syndrome and other cumulative disorders).

2.0 INTRODUCTION

Newport News Shipbuilding (NNS) received a purchase order from the Halter Marine Group, Inc. to manage the development and conduct an evaluation of welding accessories identified as the result of a funded National Shipbuilding Research Program (NSRP) project entitled "Accessories for Enhancement of the Semi-automatic Welding Processes (GMAW/FCAW/ GTAW) ". The purchase order details were finalized and accepted during the latter part of 1997. Prior commitments and production requirements delayed the project's initiation until February 1998.

2.1 BACKGROUND

The diversity of joints to be welded often necessitates that the semi-automatic process be used in lieu of a mechanized welding process. The time to set up and relocate mechanized equipment often negates any gains in productivity over semi-automatic equipment when utilized on small jobs or short weld lengths. Also, most automated equipment, other than robotics, is for a single process/purpose and requires other types of welding equipment to complete the entire job. Manufacturers offer many methods to automate welding, but most are expensive, and require considerable set up time and support labor (i.e. maintenance, programming, and technique development).

The original undertaking of this project was the development of a simplified or poor man's mechanized welding device. Some of the operator controllable factors would be mechanized, therefore the cost of welding would be considerably reduced. The proposed accessory could be as simple as a device that is easily moved and maintains proper torch to work distance while the operator manipulates the arc and pushes or pulls for travel. This would significantly reduce their skill level and the operator fatigue factor experienced while holding the weight of the semi-automatic torch. On the other hand it could provide a pre-determined travel speed and stand off,

which would eliminate many stops and starts and provide consistent travel pace for the operator to maintain. There are many ideas, but until the users are involved and their input considered, the development and acceptability into a production environment will be minimal.

Japanese shipbuilders have been successful with simple types of mechanical and electrical welding and cutting accessories. An example of operator accessories/enhancements in the oxy/fuel and plasma cutting processes is a unit that mechanizes straight cutting, small/large circles, and profiles/bevels through a small motorized wheel. Foreign welding equipment manufacturers are hesitant to offer their products to the U.S. and when they do, it often is not state-of-the-art nor their latest technology, and is designed for their primary voltages.

2.2 WORK SCOPE

Embark on development of two or three marketable welding accessories (quantity dependent upon developmental cost) that will increase operator productivity during semi-automatic welding applications. The use of such devices should:

- ❑ decrease operator fatigue
- ❑ reduce the quantity of starts/stops in a weld joint
- ❑ allow application of a more uniform weld size
- ❑ require less hand eye coordination/skilled labor when compared to unaided semi-automatic operations

These accessories would be utilized on applications that are of insufficient length to merit the expense of using mechanized equipment or the volume of work is such that capital expenditures can not be justified. These accessories would be: inexpensive compared to their productivity gains; simple enough that the welder can improve his own productivity as conditions dictate; while maintaining the diversity that the semi-automatic equipment/process allows. Furthermore, these devices could mechanize or automate some aspect of the semi-automatic operator's controllable factors.

Ideas would be developed through solicitation of input from production welding personnel using the processes. Vendors would then be solicited to construct prototypes of those devices having the greatest potential and initial productivity benefits.

This project is divided into five basic Tasks and extends over a 36 month period. These tasks include:

- ❑ Benchmark Technology and Identify User Needs
- ❑ Prototype Specification Development and Vendor Selection
- ❑ Development of Prototype Attachment and Torch including Welding Laboratory Evaluation
- ❑ Production Evaluation – Prototype Attachment and Torches
- ❑ Final Report and Prototype Distribution

3.0 TASK I - BENCHMARK TECHNOLOGY AND IDENTIFY USER NEEDS

The general consensus of knowledgeable industry experts polled was that no identified productivity enhancements were readily available in the marketplace. No one group or person could quantify the exact attributes or specifications of a desired device. The purpose of this task was to determine if there were any accessories available in the marketplace that would enhance the performance of semi-automatic welding. If not, solicit semi-automatic operators input and develop specifications based on their workplace needs.

3.1 Marketplace Search

The first phase of Task I involved a marketplace search of the major welding equipment and associated accessory manufacturers to determine if there was any developmental work in-process or projected efforts that would meet the project's requirements. Oxygen/fuel equipment manufacturers were also contacted to determine if any of their equipment designs could be adapted for welding. The optimal accessory being sought should have some of the following desirable attributes:

- Mechanize some of the operator's controllable factors but not all.
- Attachable to the semi-auto torch and could traverse the weld joint at a pre-set speed
- Capable of maintaining proper torch to work distance. The operator would only be required to manipulate the welding arc and push or pull for travel.
- Reduce the required skill level and operator fatigue factor by holding the weight of the torch.

Conclusion

The investigation revealed that there were very few items developed for the semi-automatic welding operator that would improve his productivity or reduce the fatigue factor within a given function. During discussions with the numerous equipment manufacturers a core group interested in participating in the development of such accessories was established. With this premise the next phase of this Task was begun.

3.2 Development and Conduct Shipbuilding User Survey

Using input from numerous shipbuilding welding experts and NNS's current knowledge of semi-automatic process and application diversity, a comprehensive welder questionnaire was developed. The questionnaire was used to gather potential user requirements for formulation of mechanical and/or electrical accessory specifications. The requirements focused on those items that would offer a semi-automatic welder the most productivity advantages while minimizing his physical efforts. The "User Survey Objective and Instructions " (Table I) outlines the objectives and purpose of the survey along with the proposed usage of the acquired data and comments.

A list of interested shipbuilding participants was developed and a timetable established for completion of the survey. The comprehensive survey questionnaire was subsequently sent to seven NSRP Shipyards. Five of the seven participated, with responses and comments from 140 welders. The survey questions were designed to categorize different process users, determine current productivity trends, and identify the areas or portions of the welding equipment that create the greatest stress for the operators body and/or create the most problems during everyday welding operations. It also attempted to identify prototype devices that might have already been developed but are not commercially available.

3.3 Consolidated Survey Results

The final phase of Task I was to consolidate the survey findings, categorize the data, analyze the results and prioritize by productivity payback. The survey data was calculated using two different formats. The first format developed an average based on the collective results and total number of responses to each question (un-weighted). The second method was based on each individual shipyard's response with each shipyard having equal weight in the average calculation (weighted). Both calculations are shown in the "Consolidated User Survey/Questionnaire Results" (Table II).

3.4 Typical Semi-Automatic Welder

A synopsis of the data gathered during the survey was tabulated and the typical profile of a welder at the five participating shipyards was developed and is described below.

Gas Metal Arc Welder - Profile

- Over 50% have ten or more years of experience in GMAW & FCAW.
- FCAW is currently the primary welding process.
- Typically uses .045" diameter wire for both GMAW & FCAW processes but during FCAW will use 1/16" about 25% of the time.
- The most frequently used wire spool is 12" in diameter and weighs approximately 33 lbs.
- During a work shift, GMAW wire consumed varies from 15 - 20 lbs. while the FCAW process is between 20 & 30 lbs. This would indicate an average arc time for both processes to be from 2 to 4 hrs per work shift (based on 7 lbs./hr deposition).
- Over 70 % use less than 300 amperes of welding current for both processes.
- Flat and vertical welding positions are equally used over 75% of the time.
- The overhead position creates the greatest fatigue.
- The welding torch angle and travel speed are the most difficult to consistently maintain.
- A wire feeder will be moved by over 50% of those surveyed a minimum of six times with 50% of those moving it more than ten times.
- When moving the feeder, 85% of those surveyed do not remove the wire spool and 46% don't even disconnect the attached cables and hoses.

- ❑ The majority of those surveyed wanted a lighter torch and cables. This was rated Number 1 and reducing the weight of the wire feeder was an item that should be considered by individual shipyards.
- ❑ Homemade welding accessories for torch angle, tip-to-work distance, and travel speed were being used by 11% of those that responded.

Manual Gas Tungsten Arc Welder - Profile

The profile for a GTAW operator could not be developed due to the small sampling quantity that participated in the survey. Based on the limited information only several comments or conclusions could be provided.

- ❑ Of those surveyed, 19% were GTA welders and 50% had more than ten years experience.
- ❑ The majority used 3/32' tungsten and deposited less than 2 lbs. of weld metal per shift.
- ❑ Average welding current was less than 200 amperes.

3.5 Conclusions and Recommendations

Based on the responses and identified needs outlined in the "Consolidated User Survey/Questionnaire Results", a conclusion was developed as to the most desirable productivity enhancement or improvement. The recommendations concluded that a lightweight air cooled torch and cables would provide the greatest productivity payback for the semi-automatic GMAW and FCAW operator. The second most desirable enhancement was described as a device that would attach to the torch and maintain a preset (operator adjustable) torch angle and/or tip-to-work distance.

4.0 TASK II – Prototype Specification Development and Vendor Selection

The recommendations of Task I concluded that a lightweight air cooled welding torch and torch attachment device would provide the greatest productivity payback for the simulated semi-automatic GMAW and FCAW operator. This task will undertake development of specifications for both productivity enhancements as described in the user survey and contract with equipment manufacturers to develop working prototypes.

4.1 Lightweight Torch and Attachment Development

Specifications and operating characteristics for both the lightweight torch and the torch attachment device were developed based on user input from the "Consolidated User Survey/Questionnaire Results" (Table II). These prerequisites and the purchase order criteria for the Lightweight Torch and Torch Attachment Device are shown in Tables III and IV respectively.

Six major manufacturers of GMAW/FCAW torches were contacted concerning existing product availability and their interest in participating in this project. The manufacturers include: Bernard/DovaTec Ltd; ESAB Welding and Cutting; M. T. Gilliland, Inc.; Lincoln Electric; Thermadyne Tweco; and OXO Welding Equipment Company.

During this same time period, six major manufacturers of welding accessories were contacted concerning existing product availability and their interest in participating in this project. These manufacturers include: BUGO Welding Systems, Inc.; Gullco Welding and Cutting Automation; Koike Aronson, Inc.; Kroll Technologies; Thermadyne Tweco/Arcair; and Weld Systems Intl. Inc.

Each manufacturer was informed of the project's overall objective and the feedback received from the "User Survey". All were interested in receiving the request to bid/evaluate the purchase order specifications.

4.2 Conclusion

Purchase order development, solicitation of bids, selection of supplier and the placement of purchase orders were completed. Purchase orders were awarded to Bernard/DovaTech, Thermadyne/Tweco, and OXO Welding Equipment Company for development of the prototype lightweight FCAW/GMAW torches. Additional purchase orders were awarded to BUG-O Systems and Kroll Industries for development of the prototype GMAW/FCAW Torch Attachments. Discussions were held with each of the purchase order recipients pertaining to the project's milestones and pertinent technical details.

5.0 TASK III – Development of Prototype Attachment and Lightweight Welding Torch

This Task addresses the development of a prototype lightweight torch and a prototype torch attachment for the purpose of enhancing the semi-automatic GMAW and FCAW welding processes. For reporting purposes this Task has been divided into **Part I "Lightweight Torch"** and **Part II "Torch Attachment".** Outlined in the succeeding sections, individual details and actions taken to complete this task are described.

5.1 Part I - Lightweight Welding Torch

Welding torch manufacturers DovaTech, Ltd. (Bernard), OXO Welding Equipment Co. and Tweco-Arcair each developed a lightweight torch based on issued purchase order specifications. NNS reviewed their conceptual designs/preliminary prototypes and concurred with continued development of the torches for conducting the Welding Lab and subsequent Production Evaluations. Each manufacturer incorporated NNS's

feedback into the final prototype torch conceptual design and met the purchase order specifications and project task requirements. Final prototype torches were delivered to NNS during September and October 1999 so that the Welding Lab Evaluation could commence.

5.2 Part II - Prototype GMAW/FCAW Torch Attachment

BUG-O Systems Inc. and Kroll Technologies are the manufacturers involved with the torch accessory portion of the project. NNS performed evaluations of the preliminary prototype torch attachments and provided comments to the manufacturers. Each produced a preliminary prototype torch attachment that conceptually met the project task requirements. Each manufacturer had produced a unique design of which a description is provided below.

5.2.1 Weld Tooling/BUG-O Systems Attachment

The BUG-O representatives met with NNS and presented their conceptual torch attachment (Figure 1). There was an exchange of ideas and several suggested improvements. They agreed to incorporate the ideas and within 60 days re-submit prototype for evaluation.

- It is a "moon-rover" type device that can be operated manually or by an optional drive motor.
- The drive motor unit is equipped with a toggle switch to control on/off, forward and reverse. It also has a variable speed control knob.
- This device is limited to flat and horizontal applications. The outer edge of the wheels have a 45° bevel that enables the device to traverse a "tee" type joint with two wheels on the vertical member and two wheels on the flat member.
- The torch is easily attached and detached from the device.

5.2.2 Kroll Industries Attachment

Kroll representatives met with NNS and presented their conceptual torch attachment (Figure 2). We attempted to set the unit up on a steel plate in the horizontal position and connect a welding torch to simulate welding. Problems were encountered securing the unit to the plate and we determined that the torch connection device was entirely too complicated. NNS and the Kroll representative both concluded that the unit needed additional design work and factory testing.

- The original design consists of a three-wheel "car" attached to a 3-foot long aluminum extrusion (other lengths available).
- The car traverses the extrusion and weld joint in the manual mode. The extrusion is aligned with the weld joint and held in place by magnets. This allows the device to be used in all positions.
- The torch is easily attached and detached from the "car". The method of torch attachment gives a welder the option of torch manipulation/weaving.

5.3 Conclusions

Preliminary reviews of the developed lightweight torch prototype and torch attachments looked very encouraging and their likelihood of successful completion of their task appeared to be imminent.

6.0 TASK IV – Welding Lab Evaluation of Developed Prototypes

The task objective was to perform a Welding Lab evaluation and upon successful completion the project would then move into a production/field evaluation. The Welding Lab evaluation includes a series of non-destructive tests on completed welds to ensure that the prototypes' performance complies with the purchase order specifications and meets NNS's contractual/production procedural quality and performance requirements. Additional evaluation factors included functional operability, maintainability, and operator appeal. This screening process assures that sub-standard equipment is not used in production applications. For reporting purposes this Task has been divided into **Part I "Lightweight Torch"** and **Part II "Torch Attachment".**

6.1 Part I – "Prototype Lightweight Torch"

NNS completed the "Lightweight Torch" Welding Lab Evaluation and documented the results based on the input of Welding Lab technicians, engineers, production welders, and the Project Leader's observations. Summaries of the tests performed and subsequent recommendations were forwarded to each torch manufacturer via memorandum. Included were torch testing data and NNS's recommendations.

A summary of the comments sent to each torch manufacturer is outlined in the following paragraphs while the actual Welding Lab Evaluation Sheets are shown in Table V - DovaTech, Table VI - OXO Welding Equipment Co., and Table VII - Tweco-Arcair. The torches were returned to the manufacturers' facility for their review and implementation of the recommended changes.

6.1.1 DovaTech

Observations

- The overall torch configuration was well received. The ergonomic handle, swivel neck design, and overall appearance of the torch received very good reviews.
- The power cable was extremely lightweight and received very high comments. The operators were also pleased with its' balance.
- There were numerous comments concerning the uniqueness of the swivel neck and quick-change body tubes with separate jumper liner. It was felt, this offered significant advantages to the operator if he required numerous torch neck changes on-the-job site.

- The use of a jumper liner in the neck in lieu of a continuous liner has some distinct advantages. Torches with a continuous gun liner and replacement neck feature would require a liner change/alteration when a different length swivel neck is used.
- The contact tip and nozzle assemblies were the only areas to receive negative comments, especially when welding in the upper parameter ranges (duty cycle testing phase).

  User Concerns

  1. Contact tip burn-back was due to the tip becoming loose and slipping out and the nozzle not staying secure on the torch.
  2. Some of the evaluators had problems adapting to the "Elliptical Contact Tip" design. Difficulties were also encountered when inserting a new tip once some spatter had adhered to the diffuser.
  3. The operators use long nose pliers not a wrench to install and remove contact tips. Pliers are one of their standard tools for spatter, nozzle and tip removal.
- Based on our concerns and discussions with the manufacturer about the contact tips, a different model was supplied and evaluated. The users were very pleased with the second model and additional testing concluded that the torch met specification criteria.

Recommendations to the Manufacturer

- Ensure that the gas diffuser (Series 4635), cup (Series 36), and contact tip (Series 1500) combinations are used to set up the Production Prototypes.
- Conclusions related to the elliptical contact tip will be deferred until more users have an opportunity to conduct their evaluation.
- Determine if a "locking type trigger " is feasible with the prototype's current design configuration.

6.1.2 OXO Welding Equipment Co.

Observations

- The overall torch configuration and head design (quik-tip & quik-nozzle design) were well received. The ergonomic handle, locking trigger, swivel neck, and overall appearance of the torch received very good reviews.
- The initial torch submitted (Prototype I) had a 300-Amp power cable and steel sheath on the gun neck. During duty cycle testing, problems were encountered with over-heating of the nozzle, neck assembly and tip. Several times during testing the contact tip appeared to close-up resulting in a tip burn-back. Conversations with the factory indicated that the original torch's cable/neck were marginal for the requested

ampere/duty cycle. A replacement, 400–Amp model of the same design and features. Prototype II, was shipped overnight so the evaluation could continue.

- All users agreed that the "locking trigger" was a definite benefit and should be included on "production evaluation Prototypes".
- Welding Lab test results concluded that **Prototype II** met purchase order performance specifications, operating characteristics, and is ergonomically balanced to minimize fatigue.
- When welding parameters were in the upper ranges with Prototype II wire feeding problems surfaced resulting in seizing of the weld wire and subsequent contact tip burn-back. Color changes were noticeable starting around the threaded area of the tip and moving up the tip. Investigations revealed that the contact tip inside diameter was .052". We felt this was too tight for proper clearance especially at the higher amperage ranges of .045 wire diameters. Alternate contact tips were provided after the problem was discovered. They were .062" ID and further testing resulted in satisfactory results at the upper amperage ranges.

Recommendations

- Include the "locking trigger" on the "Production Prototypes" to enhance it's overall performance.
- The last torch furnished (400 ampere model) is the only acceptable unit.
- Contact tips to be supplied for "Production Evaluation" must be .055 - .062 "ID.
- Resolve problem of overheating in the contact tip, nozzle and tip area.

6.1.3 Tweco-Arcair Lightweight Torch

Observations

- The overall torch configuration and four piece head design (collet & slip-in tip design) was well received. The alternative screw-in tip type gas diffuser did not meet the specification criteria therefore it was not evaluated.
- High points were scored for the head's simplicity, reliability and ease of contact tip and nozzle replacement.
- The handle, swivel torch neck and lightweight uni-cable were very user friendly and received very good comments.
- Several of the Tweco test plates were unsatisfactory based on small RT porosity indications. These indications seemed to show up when parameters were not absolutely perfect.
  1. Investigations of the prototype nozzle revealed that the clearance between the tip locking nut housing and gas diffuser ports

appeared minimal, especially after the nozzle was exposed to high amperages.

2. Tweco was working on a production nozzle assembly that had poured epoxy insulation instead of the crimped mica paper. NNS was sent this new design which provided additional clearances for gas flow and significantly improved overall gas shielding properties.

- Final Welding Lab test results concluded that the torch met purchase order performance specifications, operating characteristics, and appears to be ergonomically balanced to minimize fatigue.

Recommendations to the Manufacturer

- If feasible, a "locking trigger" should be added to the "Production Prototypes" to enhance it's overall performance.
- Gas nozzles to be provided for production evaluation must be the poured epoxy type and provide additional clearance in the gas diffuser area to enhance and improve gas shielding of the arc.

6.1.4 Conclusion Lab Evaluation – Prototype Torches

NNS completed the "Lightweight Torch" Welding Lab Evaluation and documented the results. Summaries of the tests performed and subsequent recommendations were forwarded to each torch manufacturer via memorandum. Included were torch testing data and NNS's recommendations. The comments and recommendations were based on the evaluator's comments, input from the Lab Welding Engineer, and Project Leader observations. The torches were returned to the manufacturers for implementation of recommended changes.

6.2 Part II "Prototype GMAW/FCAW Torch Attachment" - Unsuccessful

As of February 2000, neither of the manufactures had satisfactorily developed a prototype torch attachment. Initial attempts to begin the Welding Lab Evaluation failed to produce any worthwhile advantages over standard semi-automatic operations. In most instances the use of these attachments was detrimental to overall productivity. The deficiencies of each unit were discussed with the manufacturers and they diligently worked to develop an improved design. Outlined in the following statements are some of the preliminary evaluation comments.

6.2.1 BUG-O Attachment (Cancelled)

- In the flat position, the tractor would not travel in a straight line.
- In the 45 degree position, the tractor would not travel in a straight line, it would either favor the vertical or horizontal plate.
- It was difficult to guide the tractor while welding. The operator spent more time guiding the tractor than concentrating on the weld puddle.

6.2.2 Kroll Industries Attachment (Cancelled)

- The slide was too heavy, difficult to align to the weld joint, and torch holder did not slide smoothly.
- Forward force with the torch caused binding and it would not slide.
- The torch holding mechanism is too complicated and restrictive. It does not allow necessary movement of the torch.

6.2.3 Conclusion Lab Evaluation – Prototype Torch Attachment

Newport News Shipbuilding personnel worked with both vendors in a joint effort to develop an attachment that would enhance the productivity of the semi-automatic welder by minimizing fatigue and improving the effectiveness of one or more of his controllable factors. Neither of the vendors has been able to produce a satisfactory "Torch Attachment" as described with the purchase order specifications. This lack of performance was not due to unsatisfactory effort but primarily to their inability to develop an attachment that produces the desired results. NNS concludes that a reasonable good faith effort was expended on behalf of the vendor and the result was due to the complexity of the task. Based on these conclusions NNS and the vendors mutually agreed to the cancellation of the purchase orders and development of the "Torch Attachment" would be not pursued further. NNS still feels that the idea has great potential but will required a very unique design.

7.0 TASK IV Lightweight Torch Production Evaluation

In March 2000, each torch manufacturer completed the recommended changes and supplied twelve torches to NNS along with wire feeder adapters and necessary welding consumables to conduct the "Production Evaluation".

The SP-7 Panel shipyards requesting to participate in the "Production Evaluation" include NASSCO, Atlantic Marine, Ingalls, Electric Boat, Avondale Industries, Bath Iron Works, and Newport News Shipbuilding. Due to the wide variety of wire feeders used by the participating Shipyards and some having special modifications, it was a challenge to obtain the correct torch adapter to suit the torches being evaluated. Problems obtaining the correct adapters delayed initial "Evaluation Start Up" for some of the Shipyards for up to six weeks.

7.1 Evaluation Scope

During the months of April, May, and June 2000, NNS shipped three torches (one from each manufacturer) to the participating shipyards. Included with the torches was: background information on the project; criteria for conducting the evaluation; personnel contacts if assistance was required; the requested time duration of the evaluation; and necessary welding torch consumables/wire feeder adapters. The last torch shipment was made in July 2000 after procuring necessary wire feeder adapters to facilitate usage with their particular wire feeder.

An "Evaluation Summary Form" (Table V – same as used for the Welding Lab evaluation) and instructions were included in the shipping carton sent to each shipyard. Evaluators were requested to have the welder complete the required fields. The instructions also asked that each welder have an opportunity to evaluate each of the manufacturer's torches, so that we could develop a consensus of opinion as to the optimum qualities needed by shipbuilding welders

7.2 Production Evaluation

By September 2000 each of the evaluating shipyards had completed their production evaluation and returned the torches to Newport News Shipbuilding. The evaluation survey data was compiled and consolidated into a format that would provide a direct torch comparison by attribute. There were approximately 120 individual responses resulting in a range of 30 to 40 evaluators per torch type. Some welders evaluated all three torches, while others only used a single manufacturers' type.

Due to the wide variation in the number of participants from the different shipyards, the data was calculated by two different methods. The first format developed an average based on the collective results and total number of responses to each question "un-weighted). The second method was based on each individual shipyard's response with each shipyard having equal weight in the average calculation (weighted). Both calculations are shown in the "Production Evaluation Response Summary-All Torches" in Table VIII. This table is a consolidation of all evaluators responses by manufacturer and attribute and offers the ability to compare evaluation results and also illustrates the spectrum of variation within the ranges.

7.3 Existing Welding Torches Used for Comparison

The evaluation instructions requested that each evaluator compare the torch being evaluated to others he had previously tested and the ones that he used on a daily basis to perform his job function. A listing of some torches that are currently being used by the seven shipyards that participated in the evaluation are shown in the table below.

Examples of Shipyard Welding Torches Used for Comparison - Air Cooled -

Manufacturer	Model	Length (ft.)	Current Rating (Amps)
OXO Welding	FW-400	10 ft.	400
OXO Welding	AP-20	10 ft.	200
Arcsmith – PieceMaker	PM40-A	12 ft.	400
M.T. Gilliland	MTG-4000	10 ft.	250-300
Tregaskiss		12 ft.	400
Tweco	No. 3	10 ft.	280-300
DovaTech/Bernard	EZ-200	10 ft.	200

7.4 Torch Manufacturer Feedback/Final Prototype Design

Initially the production evaluation feedback was categorized by manufacturer. Also included were the individual operator comments as written on the form by the evaluator. "Production Evaluation Summary" Tables IX –DovaTech. Table X – OXO, and Table XI – Tweco outline the total response feedback by manufacturer. Individual user comments were included in the Evaluation Summary attachments by attribute but these comments do not necessarily convey the overall percentage rating or consensus of the evaluators. The comments were provided strictly for information purposes.

The torches used during the Production Evaluation were shipped back to each manufacturer for their evaluation. Some torches were used daily while others might have only received a cursory review. The manufacturer was asked to scrutinize the torches for wear, overheating, deterioration and review the recommendations concluded by the production survey and interject any improvements they might suggest for the final prototype model. Based on the review of these torches and the "Production Evaluation" results the following recommendations were submitted for each torch.

7.4.1 DovaTech Evaluation Recommendations/Comments

Comments

- There were numerous comments related to the DovaTech contact tip design. It took some time to get familiar with and understand its design purpose. Once the user was comfortable with the off-set lock and learned that the tip must cool down before attempting removal, the comments were positive.
- NNS noted one common overheating concern during the inspection of the torches after the Production Evaluation. On all of the torches, not only DovaTech's, the swivel neck could be re-positioned by hand without much effort. All of the necks featured a knob for loosing or tightening the securing nut by hand.
- Many users felt that the torch neck should be insulated by an outer jacket, netting or mesh. They were concerned that when welding in vertical & overhead positions, spatter often collects between the diffuser/tip and cup thereby when the neck body accidentally contacts the work it will short out. We understand that a short is not possible in this manor.

Recommendations

- A "locking trigger" was rated as a valuable feature during the "User Survey" and the "Production Evaluation". Numerous users felt that the existing trigger was too small and difficult to feel with a gloved hand (most preferred a lever type). Improve the current design or provide new concept.
- The swivel neck is a valuable feature and liked by the users. Re-positioning of the neck should require a wrench, thereby increasing

the likelihood of the operator re-tightening to the proper torque and preventing overheating from a loose connection. Provide final prototype with an accessible insulated wrench type connection.

- The #36 two piece gas cup set was felt to be excessive, both in size and weight. This portion of the torch received the most negative comments. Provide better nozzle/cup configuration with comparable durability and less weight.
- Implement any other improvements that you determine necessary after your review of the production evaluation torches and user comments.

7.4.2 OXO Evaluation Recommendations/Comments

Comments

- NNS noted one common overheating concern during the inspection of the torches after the Production Evaluation. On all of the torches, not only OXO's, the swivel neck could be re-positioned by hand without much effort. All of the necks featured a knob for loosing or tightening the securing nut by hand.
- There were numerous comments related to the durability and performance of the OXO torch's front-end parts/consumables. The major concern was the gas diffuser and nozzle body seizing together, spatter adhering to the diffuser and the diffuser unscrewing from the tube assembly. Some of these problems could be related to the swivel neck problem discussed in the previous comment.

RECOMENDATIONS

- The "locking trigger" was rated as a valuable feature during the "User Survey" and the "Production Evaluation". Numerous users felt that the existing trigger was too small and difficult to feel with a gloved hand (most preferred a lever type). The locking button design location was well received but most felt the button was too small. Improve the current design or provide new concept.
- The swivel neck is a valuable feature and liked by the users. Re-positioning of the neck should require a wrench, thereby increasing the likelihood of the operator re-tightening to the proper torque and preventing overheating from a loose connection. Provide final prototype with an accessible insulated wrench type connection.
- Investigate the overheating of front-end consumable parts and seizing of gas diffuser to cup. Correct problem or provide better nozzle/diffuser configuration with comparable durability.

- Determine the cause and corrective action to prevent the gas diffuser from coming off with the gas cup and reduction of excessive spatter build up on the diffuser itself. Improve the method of securing gas diffuser to gun tube & reduction of spatter build up.
- The weight and stiffness of the power cable received quite a few negative comments. The original power cable was an issue during the Weld Lab evaluation (got too hot for rated amperage). Provide improved power cable if available.
- Implement any other improvements that you determine necessary after your review of the production evaluation torches and user comments.

7.4.3 Tweco Evaluation Recommendations/Comments

Comments

- There were numerous comments related to the Tweco torch overheating at the tip/gas diffuser assembly and others commented on seizing of the nozzle diffuser and cup.
- NNS noted one common overheating concern during the inspection of the torches after the Production Evaluation. It could be related to one or all of the above problems. On all of the torches, not only Tweco's, the swivel neck could be re-positioned by hand without much effort. All of the necks featured a knob for loosening or tightening the securing nut by hand.

RECOMENDATIONS

- The "locking trigger" was rated as a valuable feature but the current locking design was not rated very high. The locking rod was difficult to manage, the knob on the rod was lost or damaged easily, and the trigger would stick in position sometimes when locked. Improve the current design or provide new concept.
- The swivel neck is a valuable feature and liked by the users. Re-positioning of the neck should require a wrench, thereby increasing the likelihood of the operator re-tightening to the proper torque and preventing overheating from a loose connection. Provide final prototype with an accessible insulated wrench type connection.
- The gas cup does not tighten securely to the diffuser nor does it remain secure after several cycles of welding. The diffuser seizes to the gas cup and cannot be removed or the cup becomes too loose. Provide better connection method or thread design.
- Implement any other improvements that you determine necessary after your review of the production evaluation torches and user comments.

7.5 Production Evaluation Summary

The following conclusions are base on the ratings and comments from each of the evaluators during this evaluation. Some comments and ratings appear to be based on a lack of familiarity with a particular torch and understanding of its design features. This conclusion, of which all manufactures concurred, was that the welder himself is not always provided explicit instructions as to the idiosyncrasies of new torches. All agreed that a method to get information directly to the welder was needed (operator instructions are too detailed).

Based on the feedback from the welders evaluating the prototype torches and their recommendations the following conclusions were developed.

- All torches were rated high for their performance to specifications with Tweco being rated best and Oxo Welding a close second.
- In the area of gas coverage, all torches were rated equal to or better than the current welding torches being used.
- The Tweco received the highest ratings for handle temperature, cable weight/flexibility and overall operators appeal.
- The Oxo Welding torch received the highest percentage rating in eight of the fourteen attributes including overall consumable life and user friendly front end parts.
- Based on the user feedback, none of the torches in their present configuration will significantly improve current productivity of the entire welder base being surveyed.
- Shipyards, which use higher amperage rated torches, could see some benefits to these designs.
- Shipyards that use higher current rated torches could see some benefits to the torch designs being evaluated. It appears that some shipyards are using torches with much lower amperage ratings (i.e. 200 A) and lower welding duty cycles than the data obtained from the "User Survey". This factor would allow their current torches to be much lighter/smaller or equal to those tested.
- The swivel neck is a valuable feature and liked by the users. Re-positioning of the neck should require a wrench, thereby increasing the likelihood of the operator re-tightening to the proper torque and preventing overheating from a loose connection.

8.0 TASK V - Final Report and Conclusions

The Production Survey feedback and comments concluded that none of the "Lightweight torches" in their present configuration will significantly improve productivity of the entire welder base being surveyed. It was understood from the beginning of this project that there would not be a "Fits All" torch that met all the desirable attributes of all welders and all shipyards.

Some shipyards utilize one type or model of torch and use it across a wide welding current range while others have multiple torch models and apply them to specific applications and current ranges. This compounds the task of developing a torch with welding current capabilities that span across multi-ranges. It appears that some surveyed Shipyards are using torches with much lower amperage ratings (i.e. 200 A) and lower welding duty cycles allowing their existing torches to be much lighter and smaller. Shipyards, which use higher amperage rated torches, could see some benefits to these designs.

Based on the feedback from the welders evaluating the prototype torches and their recommended changes, three quality-made lightweight torches will be available and designed with shipbuilding construction applications in mind. Final changes and recommendations were incorporated in the final prototype torch design and returned to Newport News Shipbuilding.

The completion of this project has greatly improved the welding equipment manufacturers' knowledge, torch design, appreciation for the application challenges, and welding application diversity faced by the shipbuilding industry. Future welding equipment designs should incorporate the identified needs described in the "User Survey" and the candid feedback outlined in the "Production Evaluation". Some of the welding torch design innovations developed as a result of this project are provided below:

- Ultra lightweight and flexible torch cables
- Improved gas flow patterns via improved gas diffusers
- Innovative power cable designs and associated compression fittings
- Modified torch body and tube designs to reduce heating
- Reduced handle temperatures at rated welding outputs
- Improved nozzle/body assembly designs
- Development of ergonomic torch configurations with user proven consumables

NNS distributed a final prototype design from each manufacturer to all seven of "Production Evaluation" participants. The individual shipyards can conduct their own evaluation of the final prototype designs and, based on their identified welding

requirements, pursue their specific torch requirements with the manufacturers of their choice.

Although the development of the "Torch Attachment" was unsuccessful there is still a need for this type of accessory to further enhance the abilities and physical restraints and limitations encountered by the semi-automatic welder in a shipbuilding environment.

USER SURVEY OBJECTIVE AND INSTRUCTIONS

OBJECTIVE

Identify specific phases/operations, performed while welding with the semi-automatic process, that could be more productive if a suitable mechanical/electrical accessory was available. The development of these accessories for work normally performed by the operator should significantly reduce operator hand to eye coordination requirements thereby enhancing their performance, increasing productivity, improving weld quality and reducing operator fatigue. These devices could mechanize or automate some of the semi-automatic operator's controllable factors but not all. Ideas will be developed through the input of production welding personnel using the processes. Prototypes will be manufactured of those devices having the greatest potential and initial productivity benefits. Additional benefits should include reducing the incidence of welding related industry injuries (ie. carpal tunnel syndrome and other cumulative disorders). This Project is funded by the SP-7 Welding Panel of the National Shipbuilding Research Program. The accessories developed as a result of this Project will be available for testing by SP-7 Member Shipyards.

PURPOSE

These accessories will be designed primarily to enhance productivity of personnel using semi-automatic equipment performing Gas Metal Arc Welding (GMAW), Flux-Cored Arc Welding (FCAW) and Manual Gas Tungsten Arc Welding GTAW). The information and ideas obtained through the attached survey will be used to determine the potential need and priorities of shipbuilding welders for the development of semi-automatic welding accessories (mechanical and/or electrical).

USER SURVEY QUESTIONNAIRE

Please distribute this survey questionnaire to a representative number (50 samples or more) of your semi-automatic welding personnel. Any feedback from welding supervisors and or other associated personnel would also be very valuable. The feedback results from this survey will be documented and provided to the SP-7 Panel.

Questions or comments contact: **Newport News Shipbuilding**
4101 Washington Avenue
Newport News, Va. 23607-2770
Attention: D. M. Wheeler, 037 Dept., Bldg. 167/2

DISTRIBUTION: Questionnaire/Survey (4/22/98)

Bath Iron Works – Dave Forrest
Ingalls - Lee Kvidahl
Electric Boat - Warren Mayott
NASSCO - Mike Sullivan
Avondale Industries - Pat Hoyt
Puget Sound Naval SY - Paul Sims

Table I

Consolidated User Survey/Questionnaire Results

1. How many years have you been welding with the following processes?

a. Semi-Auto GMAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 1 year	**8%**	**6%**	**(4)**	17%	(1)	0%	0	14%	(2)	8%	(1)	0%	0
(2) 1 to 5 years	**20%**	**17%**	**(12)**	33%	(2)	0%	0	7%	(1)	50%	(6)	8%	(3)
(3) 5 to 10 years	**2%**	**4%**	**(3)**	0%	0	0%	0	7%	(1)	0%	0	5%	(2)
(4) 10 years or longer	**70%**	**73%**	**(51)**	50%	(3)	100%	(1)	71%	(10)	42%	(5)	87%	(32)

b. Semi-Auto FCAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 1 year	**0%**	**1%**	**(1)**	0%	0	0%	0	0%	0	0%	0	2%	(1)
(2) 1 to 5 years	**16%**	**25%**	**(30)**	10%	(2)	0%	0	7%	(1)	41%	(18)	23%	(9)
(3) 5 to 10 years	**14%**	**19%**	**(23)**	5%	(1)	0%	0	20%	(3)	30%	(13)	15%	(6)
(4) 10 years or longer	**70%**	**55%**	**(66)**	85%	(17)	100%	(1)	73%	(11)	30%	(13)	60%	(24)

c. Manual GTAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 1 year	**8%**	**8%**	**(6)**	14%	(1)	0%	0	13%	(2)	7%	(2)	4%	(1)
(2) 1 to 5 years	**8%**	**12%**	**(9)**	0%	0	0%	0	7%	(1)	11%	(3)	21%	(5)
(3) 5 to 10 years	**17%**	**19%**	**(14)**	29%	(2)	0%	0	20%	(3)	22%	(6)	13%	(3)
(4) 10 years or longer	**68%**	**61%**	**(45)**	57%	(4)	100%	(1)	60%	(9)	59%	(16)	63%	(15)

2. What is the primary welding process that you use performing your job?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
1. Semi-Auto. GMAW	**17%**	**14%**	**(20)**	0%	0	33%	(1)	13%	(2)	4%	(2)	33%	(15)
2. Semi-Auto. FCAW	**64%**	**67%**	**(96)**	87%	(20)	33%	(1)	81%	(13)	66%	(37)	54%	(25)
3. Manual GTAW	**19%**	**19%**	**(28)**	13%	(3)	33%	(1)	6%	(1)	30%	(17)	13%	(6)

Consolidated User Survey/Questionnaire Results

3. What is the diameter/size of the welding wire or electrode that you weld with the most?

a. Semi-Auto GMAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) .030 -	**2%**	**1%**	**(1)**	0%	0	0%	0	8%	(1)	0%	0	0%	0
(2) .035 -	**26%**	**13%**	**(9)**	33%	(2)	50%	(1)	15%	(2)	33%	(4)	0%	0
(3) .045 -	**51%**	**69%**	**(50)**	17%	(1)	50%	(1)	54%	(7)	42%	(5)	92%	(36)
(4) .052 -	**12%**	**7%**	**(5)**	33%	(2)	0%	0	0%	0	25%	(3)	0%	0
(5) 1/16 -	**9%**	**8%**	**(6)**	17%	(1)	0%	0	23%	(3)	0%	0	5%	(2)
(6) 5/64 -	**0%**	**0%**	**0**	0%	0	0%	0	0%	0	0%	0	0%	0
(7) 3/32 -	**1%**	**1%**	**(1)**	0%	0	0%	0	0%	0	0%	0	3%	(1)

b. Semi-Auto FCAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) .030 -	**0%**	**0%**	**0**	0%	0	0%	0	0%	0	0%	0	0%	(1)
(2) .035 -	**1%**	**1%**	**(1)**	0%	0	0%	0	6%	(1)	0%	0	0%	0
(3) .045 -	**37%**	**54%**	**(74)**	0%	0	0%	0	47%	(8)	78%	(39)	60%	(27)
(4) .052 -	**34%**	**15%**	**(21)**	50%	(11)	100%	(1)	0%	0	18%	(9)	0%	0
(5) 1/16 -	**27%**	**28%**	**(38)**	45%	(10)	0%	0	47%	(8)	4%	(2)	40%	(18)
(6) 5/64 -	**0%**	**0%**	**0**	0%	0	0%	0	0%	0	0%	0	0%	0
(7) 3/32 -	**1%**	**1%**	**(2)**	5%	(1)	0%	0	0%	0	0%	0	0%	0

c. Manual GTAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) .030 -	**1%**	**1%**	**(1)**	0%	0	0%	0	0%	0	4%	(1)	0%	0
(2) .035 -	**1%**	**1%**	**(1)**	0%	0	0%	0	0%	0	4%	(1)	0%	0
(3) .045 -	**5%**	**7%**	**(5)**	0%	0	0%	0	6%	(1)	4%	(1)	14%	(3)
(4) .052 -	**1%**	**3%**	**(2)**	0%	0	0%	0	0%	0	4%	(1)	0%	0
(5) 1/16 -	**39%**	**35%**	**(24)**	33%	(1)	50%	(1)	35%	(6)	8%	(2)	68%	(15)
(6) 5/64 -	**1%**	**1%**	**(1)**	0%	0	0%	0	6%	(1)	0%	0	0%	0
(7) 3/32 -	**53%**	**51%**	**(35)**	67%	(2)	50%	(1)	53%	(9)	76%	(19)	18%	(4)

Consolidated User Survey/Questionnaire Results

4. What is the diameter/size of the welding wire spool that you use the most?

a. Semi-Auto GMAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) 8" (12 lb.) -	**41%**	**21%**	**(14)**	0%	0	100%	(1)	50%	(5)	50%	(7)	3%	(1)
(2) 12" (13 lb.) -	**2%**	**3%**	**(2)**	0%	0	0%	0	0%	0	7%	(1)	3%	(1)
(3) 12" (33 lb.) -	**50%**	**66%**	**(44)**	100%	(2)	0%	0	50%	(5)	14%	(2)	88%	(35)
(4) 12" (44 lb.) -	**1%**	**1%**	**(1)**	0%	0	0%	0	0%	0	0%	0	3%	(1)
(5) Other -	**7%**	**9%**	**(6)**	0%	0	0%	0	0%	0	29%	(4)	5%	(2)

b. Semi-Auto FCAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) 8" (10 lb.) -	**53%**	**36%**	**(43)**	75%	(18)	100%	(1)	44%	(7)	46%	(17)	0%	0
(2) 12" (33 lb.) -	**30%**	**41%**	**(49)**	0%	0	0%	0	50%	(8)	3%	(1)	98%	(40)
(3) Coil (60 lb.) -	**0%**	**1%**	**(1)**	0%	0	0%	0	0%	0	0%	0	2%	(1)
(4) Other -	**16%**	**22%**	**(26)**	25%	(6)	0%	0	6%	(1)	51%	(19)	0%	0

5. How much wire do you consume in an 8 hour work shift?

a. Semi-Auto GMAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 10 lbs.	**25%**	**21%**	**(14)**	33%	(2)	0%	0	45%	(5)	42%	(5)	5%	(2)
(2) 15 lbs.	**16%**	**22%**	**(15)**	17%	(1)	0%	0	9%	(1)	25%	(3)	27%	(10)
(3) 20 lbs.	**37%**	**24%**	**(16)**	17%	(1)	100%	(1)	27%	(3)	17%	(2)	24%	(9)
(4) 25 lbs.	**9%**	**21%**	**(14)**	0%	0	0%	0	9%	(1)	0%	0	35%	(13)
(5) 30 lbs.	**13%**	**10%**	**(7)**	33%	(2)	0%	0	9%	(1)	17%	(2)	5%	(2)
(6) Over 35 lbs.	**1%**	**1%**	**(1)**	0%	0	0%	0	0%	0	0%	(0)	3%	(1)

b. Semi-Auto FCAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 10 lbs.	**11%**	**13%**	**(16)**	0%	0	0%	0	30%	(6)	14%	(6)	10%	(4)
(2) 15 lbs.	**10%**	**15%**	**(19)**	5%	(1)	0%	0	10%	(2)	16%	(7)	21%	(9)
(3) 20 lbs.	**17%**	**21%**	**(27)**	33%	(7)	0%	0	15%	(3)	18%	(8)	21%	(9)
(4) 25 lbs.	**23%**	**30%**	**(38)**	29%	(6)	0%	0	25%	(5)	27%	(12)	36%	(15)
(5) 30 lbs.	**35%**	**19%**	**(24)**	29%	(6)	100%	(1)	15%	(3)	23%	(10)	10%	(4)
(6) Over 35 lbs.	**3%**	**3%**	**(4)**	5%	(1)	0%	0	5%	(1)	2%	(1)	2%	(1)

Consolidated User Survey/Questionnaire Results

c. Manual GTAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 2 lbs.	**41%**	**56%**	**(34)**	0%	0	0%	0	91%	(10)	50%	(11)	62%	(13)
(2) 5 lbs.	**37%**	**26%**	**(16)**	17%	(1)	100%	(1)	9%	(1)	36%	(8)	24%	(5)
(3) 10 lbs.	**16%**	**11%**	**(7)**	67%	(4)	0%	0	0%	0	9%	(2)	5%	(1)
(4) 15 lbs.	**3%**	**5%**	**(3)**	0%	0	0%	0	0%	0	5%	(1)	10%	(2)
(5) Over 20 lbs.	**3%**	**2%**	**(1)**	17%	(1)	0%	0	0%	0	0%	0	0%	0

6. What is the range of welding amperage/current that you use most of the time?

a. Semi-Auto GMAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 200 -	**38%**	**22%**	**(13)**	25%	(1)	100%	(1)	33%	(4)	14%	(1)	17%	(6)
(2) 200 to 250 -	**30%**	**43%**	**(26)**	25%	(1)	0%	0	33%	(4)	43%	(3)	50%	(18)
(3) 250 to 300 -	**24%**	**28%**	**(17)**	25%	(1)	0%	0	25%	(3)	43%	(3)	28%	(10)
(4) 300 to 350 -	**8%**	**7%**	**(4)**	25%	(1)	0%	0	8%	(1)	0%	0	6%	(2)
(5) above 350 -	**0%**	**0%**	**0**	0%	0	0%	0	0%	0	0%	0	0%	0

b. Semi-Auto FCAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 200 -	**15%**	**15%**	**(18)**	10%	(2)	0%	0	44%	(7)	0%	0	21%	(9)
(2) 200 to 250 -	**60%**	**54%**	**(66)**	70%	(14)	100%	(1)	13%	(2)	55%	(23)	60%	(26)
(3) 250 to 300 -	**15%**	**16%**	**(20)**	0%	0	0%	0	44%	(7)	14%	(6)	16%	(7)
(4) 300 to 350 -	**9%**	**13%**	**(16)**	10%	(2)	0%	0	0%	0	31%	(13)	2%	(1)
(5) above 350 -	**2%**	**2%**	**(2)**	10%	(2)	0%	0	0%	0	0%	0	0%	0

c. Manual GTAW	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 200 -	**83%**	**84%**	**(53)**	50%	(3)	100%	(1)	90%	(9)	92%	(22)	82%	(18)
(2) 200 to 250 -	**11%**	**10%**	**(6)**	33%	(2)	0%	0	10%	(1)	4%	(1)	9%	(2)
(3) 250 to 300 -	**6%**	**6%**	**(4)**	17%	(1)	0%	0	0%	0	4%	(1)	9%	(2)
(4) 300 to 350 -	**0%**	**0%**	**0**	0%	0	0%	0	0%	0	0%	0	0%	0
(5) above 350 -	**0%**	**0%**	**0**	0%	0	0%	0	0%	0	0%	0	0%	0

Consolidated User Survey/Questionnaire Results

7. Which welding position do you weld the majority of the time?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
1. Flat	**37%**	**38%**	**(77)**	48%	(14)	25%	(1)	40%	(12)	33%	(26)	40%	(24)
2. Vertical	**34%**	**36%**	**(72)**	48%	(14)	25%	(1)	27%	(8)	40%	(31)	30%	(18)
3. Horizontal	**14%**	**12%**	**(25)**	3%	(1)	25%	(1)	17%	(5)	10%	(8)	17%	(10)
4. Overhead	**14%**	**13%**	**(27)**	0%	0	25%	(1)	17%	(5)	17%	(13)	13%	(8)

8. Which welding position is the most tiring or creates the greatest fatigue for YOU?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
1. Flat	**9%**	**10%**	**(14)**	5%	(1)	0%	0	20%	(3)	13%	(7)	7%	(3)
2. Vertical	**6%**	**7%**	**(9)**	18%	(4)	0%	0	7%	(1)	7%	(4)	0%	0
3. Horizontal	**1%**	**2%**	**(3)**	0%	0	0%	0	0%	0	4%	(2)	2%	(1)
4. Overhead	**83%**	**81%**	**(111)**	77%	(17)	100%	(1)	73%	(11)	76%	(41)	91%	(41)

9. During the welding operation, which process parameter do you find the most difficult to consistently maintain?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
a. Beginning of your shift													
(1) Travel Speed	**30%**	**37%**	**(42)**	56%	(10)	0%	0	25%	(3)	47%	(20)	22%	(9)
(2) Torch Angle	**35%**	**42%**	**(48)**	22%	(4)	0%	0	67%	(8)	37%	(16)	49%	(20)
(3) Tip to Work Distance	**35%**	**22%**	**(25)**	22%	(4)	100%	(1)	8%	(1)	16%	(7)	29%	(12)

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
b. Middle of your shift													
(1) Travel Speed	**30%**	**40%**	**(47)**	40%	(8)	0%	0	25%	(4)	47%	(18)	40%	(17)
(2) Torch Angle	**30%**	**36%**	**(42)**	20%	(4)	0%	0	56%	(9)	39%	(15)	33%	(14)
(3) Tip to Work Distance	**40%**	**25%**	**(29)**	40%	(8)	100%	(1)	19%	(3)	13%	(5)	28%	(12)

Consolidated User Survey/Questionnaire Results

10. If your semi-automatic welding equipment could be made lighter, which portion would you improve?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
a. First:													
(1) Wire Spool	**5%**	**7%**	**(9)**	13%	(3)	0%	0	0%	0	8%	(4)	4%	(2)
(2) Wire Feeder	**41%**	**24%**	**(33)**	30%	(7)	100%	(1)	33%	(5)	14%	(7)	27%	(13)
(3) Torch/Gun	**36%**	**45%**	**(62)**	48%	(11)	0%	0	40%	(6)	45%	(23)	46%	(22)
(4) Torch Cable	**18%**	**25%**	**(34)**	9%	(2)	0%	0	27%	(4)	33%	(17)	23%	(11)

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
b. Second:													
(1) Wire Spool	**11%**	**13%**	**(16)**	20%	(4)	0%	0	7%	(1)	7%	(3)	19%	(8)
(2) Wire Feeder	**19%**	**21%**	**(25)**	35%	(7)	0%	0	27%	(4)	21%	(9)	12%	(5)
(3) Torch/Gun	**25%**	**28%**	**(34)**	10%	(2)	0%	0	60%	(9)	31%	(13)	23%	(10)
(4) Torch Cable	**46%**	**38%**	**(46)**	35%	(7)	100%	(1)	7%	(1)	40%	(17)	47%	(20)

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
c. Third:													
(1) Wire Spool	**15%**	**18%**	**(20)**	32%	(6)	0%	0	15%	(2)	23%	(9)	7%	(3)
(2) Wire Feeder	**28%**	**42%**	**(48)**	16%	(3)	0%	0	23%	(3)	46%	(18)	57%	(24)
(3) Torch/Gun	**33%**	**18%**	**(20)**	21%	(4)	100%	(1)	15%	(2)	10%	(4)	21%	(9)
(4) Torch Cable	**23%**	**23%**	**(26)**	32%	(6)	0%	0	46%	(6)	21%	(8)	14%	(6)

11. How many times (average work shifts) do you pick up your wire feeder to move it each day?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
None	**3%**	**4%**	**(6)**	0%	0	0%	0	6%	(1)	8%	(4)	2%	(1)
Less than 4 times	**29%**	**37%**	**(50)**	9%	(2)	0%	0	50%	(8)	32%	(16)	53%	(24)
At least 5 times	**11%**	**13%**	**(18)**	4%	(1)	0%	0	25%	(4)	16%	(8)	11%	(5)
At least 6 times	**8%**	**10%**	**(14)**	17%	(4)	0%	0	6%	(1)	14%	(7)	4%	(2)
At least 7 times	**2%**	**4%**	**(5)**	4%	(1)	0%	0	0%	0	6%	(3)	2%	(1)
At least 8 times	**6%**	**7%**	**(9)**	4%	(1)	0%	0	13%	(2)	4%	(2)	9%	(4)
At least 9 times	**3%**	**3%**	**(4)**	9%	(2)	0%	0	0%	0	2%	(1)	2%	(1)
More than 10 times	**37%**	**21%**	**(29)**	52%	(12)	100%	(1)	0%	0	18%	(9)	16%	(7)

12. Do you remove the wire spool when you move your wire feeder?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
Yes	**10%**	**15%**	**(20)**	9%	(2)	0%	0	7%	(1)	14%	(7)	22%	(10)
No	**90%**	**85%**	**(115)**	91%	(21)	100%	(1)	93%	(14)	86%	(44)	78%	(35)

13. Do you disconnect the cables from the wire feeder before moving it?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	

Consolidated User Survey/Questionnaire Results

Yes	**45%**	**54%**	**(72)**	59%	(13)	0%	0	60%	(9)	57%	(29)	48%	(21)
No	**55%**	**46%**	**(61)**	41%	(9)	100%	(1)	40%	(6)	43%	(22)	52%	(23)

14. What is the normal length of your welding gun/torch?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) 8 feet	**37%**	**47%**	**(66)**	57%	(13)	0%	0	29%	(5)	53%	(28)	44%	(20)
(2) 10 feet	**48%**	**34%**	**(47)**	39%	(9)	100%	(1)	35%	(6)	17%	(9)	49%	(22)
(3) 12 feet	**12%**	**13%**	**(18)**	0%	0	0%	0	35%	(6)	17%	(9)	7%	(3)
(4) 15 feet	**2%**	**3%**	**(4)**	0%	0	0%	0	0%	0	8%	(4)	0%	0
(5) longer than 15 feet	**2%**	**3%**	**(4)**	4%	(1)	0%	0	0%	0	6%	(3)	0%	0

15. How many feet of weld do you complete while welding during a work shift (8 hrs.)?

Weld Completed	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Less than 40 ft.	**29%**	**37%**	**(47)**	13%	(3)	0%	0	50%	(7)	33%	(15)	50%	(22)
(2) 40 to 80 ft.	**21%**	**30%**	**(39)**	13%	(3)	0%	0	21%	(3)	39%	(18)	34%	(15)
(3) 60 to 100 ft.	**37%**	**21%**	**(27)**	35%	(8)	100%	(1)	14%	(2)	24%	(11)	11%	(5)
(4) More than 100 ft.	**12%**	**12%**	**(15)**	39%	(9)	0%	0	14%	(2)	4%	(2)	5%	(2)

Consolidated User Survey/Questionnaire Results

16. How many feet do you actually crawl/move your body while welding during a work shift (8 hrs.)?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
Crawl or move body													
(1) Less than 40 ft.	**33%**	**42%**	**(55)**	14%	(3)	0%	0	57%	(8)	46%	(23)	48%	(21)
(2) 40 to 80 ft.	**26%**	**35%**	**(45)**	29%	(6)	0%	0	29%	(4)	38%	(19)	36%	(16)
(3) 60 to 100 ft.	**32%**	**15%**	**(20)**	29%	(6)	100%	(1)	7%	(1)	14%	(7)	11%	(5)
(4) More than 100 ft.	**9%**	**8%**	**(10)**	29%	(6)	0%	0	7%	(1)	2%	(1)	5%	(2)

17. While performing your welding assignment, which position is your body in most of the time or at least over 50% of the time?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Standing	**14%**	**20%**	**(29)**	0%	0	0%	0	25%	(5)	29%	(16)	17%	(8)
(2) Sitting	**15%**	**17%**	**(24)**	18%	(4)	0%	0	30%	(6)	13%	(7)	15%	(7)
(3) Crouched	**19%**	**23%**	**(33)**	32%	(7)	0%	0	20%	(4)	15%	(8)	30%	(14)
(4) On hands & knees	**49%**	**37%**	**(54)**	50%	(11)	100%	(1)	20%	(4)	40%	(22)	34%	(16)
(5) Lying Down	**3%**	**3%**	**(5)**	0%	0	0%	0	5%	(1)	4%	(2)	4%	(2)

18. Are you currently using some type of homemade welding accessory or accessories that you would like to see manufactured commercially?

a.	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
Yes	**8%**	**11%**	**(15)**	0%	0	0%	0	13%	(2)	6%	(3)	23%	(10)
No	**92%**	**89%**	**(118)**	100%	(22)	100%	(1)	87%	(13)	94%	(48)	77%	(34)

b. If yes, which function of the welding process does it improve?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Travel Speed	**25%**	**18%**	**(3)**	0%	0	0%	0	0%	0	67%	(2)	8%	(1)
(2) Torch Angle	**19%**	**41%**	**(7)**	0%	0	0%	0	0%	0	0%	0	58%	(7)
(3) Tip to Work Distance	**25%**	**24%**	**(4)**	0%	0	0%	0	50%	(1)	0%	0	25%	(3)
(4) Other (explain)	**30%**	**18%**	**(3)**	0%	0	0%	0	50%	(1)	33%	(1)	8%	(1)

Consolidated User Survey/Questionnaire Results

19. If yes to No. 18, please describe your idea and provide additional information, sketches, etc.

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Additional Comments	**89%**	**91%**	**(10)**	0%	0	0%	0	100%	(2)	67%	(2)	100%	(6)
(2) No Comments	**11%**	**9%**	**(1)**	0%	0	0%	0	0%	0	33%	(1)	0%	0

20. Do you have any ideas or suggestions for an accessory that would improve or enhance the semi-automatic welding process?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
a. Yes	**16%**	**19%**	**(23)**	10%	(2)	0%	0	27%	(3)	10%	(5)	32%	(13)
b. No	**84%**	**81%**	**(100)**	90%	(19)	100%	(1)	73%	(8)	90%	(44)	68%	(28)

c. If yes, which function of the welding process does it improve?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Travel Speed	**22%**	**15%**	**(4)**	50%	(1)	0%	0	0%	0	29%	(2)	7%	(1)
(2) Torch Angle	**44%**	**50%**	**(13)**	50%	(1)	0%	0	33%	(1)	29%	(2)	64%	(9)
(3) Tip to Work Distance	**13%**	**19%**	**(5)**	0%	0	0%	0	0%	0	29%	(2)	21%	(3)
(4) Other (explain)	**22%**	**15%**	**(4)**	0%	0	0%	0	67%	(2)	14%	(1)	7%	(1)

21. If yes to No. 20, please describe your idea and provide additional information, sketches, etc.

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
(1) Additional Comments	**80%**	**57%**	**(16)**	100%	(2)	0%	0	20%	(3)	100%	(4)	100%	(7)
(2) No Comments	**20%**	**43%**	**(12)**	0%	0	0%	0	80%	(12)	0%	0	0%	0

Consolidated User Survey/Questionnaire Results

22. If a semi-automatic accessory were developed that would attach to the torch and maintain a preset-able travel speed, would you use it and would it reduce your fatigue?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
Yes	**65%**	**85%**	**(110)**	100%	(22)	0%	0	53%	(8)	84%	(42)	90%	(38)
No	**35%**	**15%**	**(20)**	0%	0	100%	(1)	47%	(7)	16%	(8)	10%	(4)

23. If semi-automatic accessory were developed that would attach to the torch and maintain a constant torch angle, would you use it and would it reduce your fatigue?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
Yes	**62%**	**80%**	**(105)**	86%	(18)	0%	0	60%	(9)	82%	(41)	84%	(37)
No	**38%**	**20%**	**(26)**	14%	(3)	100%	(1)	40%	(6)	18%	(9)	16%	(7)

24. If a semi-automatic accessory were developed that attached to the torch and maintained constant tip to work distance, would you use it (yes) (no) and/or would it reduce your fa

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
Yes	**64%**	**83%**	**(109)**	86%	(18)	0%	0	60%	(9)	86%	(43)	89%	(39)
No	**36%**	**17%**	**(22)**	14%	(3)	100%	(1)	40%	(6)	14%	(7)	11%	(5)

25. If you could chance or improve two things with the semi-automatic equipment you are using, what would those changes be?

	Weighted Total	Unweighted Total		Avondale		Ingalls		Puget Sound		NASSCO		NNS	
a. First - Yes	**80%**	**73%**	**(98)**	83%	(19)	100%	(1)	73%	(11)	58%	(31)	84%	(36)
No	**20%**	**27%**	**(37)**	17%	(4)	0%	0	27%	(4)	42%	(22)	16%	(7)
b. Second - Yes	**64%**	**54%**	**(72)**	55%	(12)	100%	(1)	60%	(9)	42%	(22)	65%	(28)
No	**36%**	**46%**	**(61)**	45%	(10)	0%	0	40%	(6)	58%	(30)	35%	(15)

Purchase Order Specifications

PROTOTYPE LIGHTWEIGHT GMAW/FCAW WELDING TORCH

General Notes

- This purchase order is the result of a funded National Shipbuilding Research Program, Panel SP-7 Project Number 7-96-6 "Accessories for Enhancement of the Semi-Automatic Welding Processes (GMAW/FCAW/GTAW)".

- The prototype torches developed through this project will be evaluated by participating member shipyards (i.e. Newport News Shipbuilding, Norfolk Navy Shipyard, Electric Boat, Bath Iron Works, NASSCO, Avondale, Ingalls, Halter-Gulfport and Alabama Ship).

- This solicitation request offers for design and construction of welding equipment which complies with the stated performance criteria. Rights and responsibilities for the equipment design, workmanship, and commercialization will be retained by the manufacturer in accordance with Federal Acquisition Regulations 52.227-11 or 52.227-12 (as applicable) entitled "Patent Rights—Retention by the Contractor". Those who submit successful offers will be required to warrant the equipment against defects in workmanship or materials and guarantee its use for the purpose intended by the stated performance criteria.

- Equipment shall comply with all applicable OSHA requirements in effect as of the time of this purchase order. Equipment shall have controls of 42 volts AC or less. All equipment and its installation shall meet applicable NEMA, NEC, or JTC Standards.

ADDITIONAL NOTES

AWARD OF THIS PURCHASE ORDER WILL BE BASED THE FOLLOWING:

1. Acceptance of project Milestones and P. O specifications
2. Each manufacturer responding to this RFQ should submit a conceptual sketch of their proposed torch, its rating and duty cycle. Torches will be rated based on their physical size and weight considering amperage rating and duty cycle. Target weight for the proposed torch is 1.5 lbs. or less.
3. The weight of the torch shall be determined as follows:
   - The torch shall be weighed with power cable attached
   - The torch shall be placed on the scale so that the end of the torch at the area of connection to the welding cable is at the edge of the scale surface
   - The welding cable shall be supported at a point 12 inches from the area of connection to the torch
   - The top of the support shall be at the same level as the top of the scale surface
4. Award consideration will be based on the RFQ response (s) that most satisfies the purchase order attributes.

Table III

5. Based on vendor response, up to three (3) purchase orders may be placed for torch prototypes.
6. An incentive fee of $5,000 will be provided upon successful completion of Milestones I, II and III outlined below.
7. A payment of $2,000 will be made upon successful completion of Milestones IV and V and Newport News Shipbuilding's receipt of a proper invoice.

MILESTONES AND PAYMENT SCHEDULES

1. Milestone I - Approximately two weeks after receipt of P.O., a meeting will be held with the vendor, NNS, and possibly a SP-7 Panel representative. The meeting will he held at the vendor facility to discuss development approach and project milestones.
2. Milestone II - Within ten (10) weeks of purchase order receipt, NNS representatives will visit the vendors plant to review and discuss progress and view the conceptual torch. Comments and recommendations will be provided.
3. Milestone III – Within twenty four (24) weeks of purchase order receipt, the vendor will demonstrate the Prototype at Newport News Shipbuilding. Testing criteria will include but not be limited to portability; operator appeal; wire feedability; durability of consumables; gas flow; temperature cooling at rated amperages, voltages and duty cycle.
   - A payment of $5,000 will be made upon successful completion of Milestones I, II, and III and Newport News Shipbuilding's receipt of proper invoice.
4. Milestone IV – Within twenty eight (28) weeks after receipt of purchase order, the vendor will have incorporated agreed upon changes (based on input from Prototype demo) and shipped the unit to NNS for Welding Lab and Production evaluations.
5. Milestone V – Within thirty two (32) weeks after receipt of purchase order, NNS will return the torches to the vendor: for their evaluation of wear, overheating, and deterioration; minor modifications/repair of any deficiencies that were found during the Production Evaluation; and refurbishment for return to NNS for evaluation by the other NSRP Shipyards.
   - A payment of $2,000 will be made upon successful completion of Milestones Nos. IV and V and Newport Shipbuilding's receipt of a proper invoice.
   - The timetables listed above are crucial to the successful completion of this project. Any unfavorable variances in designated Milestones will adversely affect the remaining Milestones in other portions of the project.
   - Any resulting purchase order will be awarded to the vendor submitting the offer that is the most advantageous to the purchaser, price and other factors considered. Other factors in order of importance shall include: NNS Quality Rating of Offerer, delivery, technical competence, the financial stability of the supplier, production capacity and impact of this award on operations, management capabilities/ support and cost controls.

DESCRIPTION

Item Qty Description

1 6 pcs. Torch -Semi-Auto Welding

Description: Develop and construct a durable, super lightweight semi-automatic air-cooled welding torch and cables to be used for GMAW-SA, GMAW-S, GMAW-P and FCAW. Consumables shall be easily replaceable by operator and require minimum maintenance. It shall meet the following performance specifications and operating characteristics:

A. Welding current operating range: 325-350 amps & 28-30 volts
B. Duty cycle: 60% (six minutes out of ten) with mixed argon gases (greater than 75% argon).
C. Wire sizes: .035 , .045 & .052" solid; .035, .045, .052 & 1/16" flux-cored
D. Contact tips: heavy duty, coarse or non-threaded with long life
E. Conductor tube angle: 60 degree
F. Gas diffuser design should provide superior gas coverage when compared to standard air cooled torches.
G. Nozzles should be heavy duty & easily removed.
H. Torch length: 10 to 15 ft.
I. Torch cables to be flexible and lightweight.
J. Wire feeder connection – Euro Type
K. Handle & trigger to be ergonomically designed.
L. The complete torch with the above attributes shall: enhance the operators ability to produce a defect free weld at the rated amperage, voltage and duty cycle; provide good wire feedability; produce minimal heat discomfort to the operator's hands; be ergonomically balanced to minimize fatigue.

2 6 pcs. Manual

Description: One operator and maintenance manual per torch supplied. Shall include exploded view of replacement parts with recommended spares and listing of manufacturer part numbers.

Purchase Order Specifications

PROTOTYPE GMAW/FCAW TORCH ATTACHMENT

General Notes

- This purchase order is the result of a funded National Shipbuilding Research Program, Panel SP-7 Project Number 7-96-6 "Accessories for Enhancement of the Semi-Automatic Welding Processes (GMAW/FCAW/GTAW)".
- The prototype semi-automatic torch attachment developed through this project will be evaluated by participating member shipyards (i.e. Newport News Shipbuilding, Norfolk Navy Shipyard, Electric Boat, Bath Iron Works, NASSCO, Avondale, Ingalls, Halter-Gulfport and Alabama Ship).
- A synopsis of the data gathered during a comprehensive Questionnaire Survey, of which five NSRP shipyards participated, concluded that devices similar to the ones described below would be desirable and could improve productivity through reduction of some repetitious physical movements performed during welding operations.
- This project is for a "Poor Man's" mechanized welding operation. Some of the operator's controllable factors will be mechanized but not all, therefore the cost should be affordable to a wider range of users.
    - The developed accessory could be a simple device that attaches to the semi-automatic torch and traverses the weld joint while maintaining proper torch to work distance. The operator would only be required to manipulate the welding arc and push or pull for travel.
    - This attachment should significantly reduce the required skill level as well as the fatigue factor of the operator holding the weight of the torch.
    - Another option would be to provide an attachment with pre-settable travel speed and tip to work stand-off, eliminating many stops and starts and providing a pace for the operator to maintain.

- This solicitation request offers for design and construction of welding equipment accessories which complies with the stated performance criteria. Rights and responsibilities for the equipment design, workmanship, and commercialization will be retained by the manufacturer in accordance with Federal Acquisition Regulations 52.227-11 or 52.227-12 (as applicable) entitled "Patent Rights—Retention by the Contractor". Those who submit successful offers will be required to warrant the equipment against defects in workmanship or materials and guarantee its use for the purpose intended by the stated performance criteria.

- Equipment shall comply with all applicable OSHA requirements in effect as of the time of this purchase order. Equipment shall have controls of 42 volts AC or less. All equipment and its installation shall meet applicable NEMA, NEC, or JTC Standards.

ADDITIONAL NOTES

AWARD OF THIS PURCHASE ORDER WILL BE BASED THE FOLLOWING:

1. Acceptance of project Milestones and P. O specifications
2. Each manufacturer responding to this RFQ should submit a conceptual sketch of their proposed Torch Attachment and performance criteria. Attachments will be rated based on their physical size, weight, productivity advantages and uniqueness.
3. Award consideration will be based on the RFQ response (s) that most satisfies the purchase order attributes.
4. Based on vendor response, possibly two (2) purchase orders may be placed for torch attachment prototypes.
5. An incentive fee of $5,000 will be provided upon successful completion of Milestones I, II and III outlined below.
6. A payment of $2,000 will be made upon successful completion of Milestones IV and V and Newport News Shipbuilding's receipt of a proper invoice.

MILESTONES AND PAYMENT SCHEDULES

1. Milestone I - Approximately two weeks after receipt of P.O., a meeting will be held with the vendor, NNS, and possibly a SP-7 Panel representative. The meeting will be held at the vendor facility to discuss development approach and project milestones.
2. Milestone II - Within ten (10) weeks of purchase order receipt, NNS representatives will visit the vendor's plant to review and discuss progress and view the conceptual torch attachment. Comments and recommendations will be provided.
3. Milestone III – Within twenty (20) weeks of purchase order receipt, the vendor will demonstrate the Prototype at Newport News Shipbuilding. Testing criteria will include but not be limited to portability; operator appeal; productivity advantages; ease of set up and operation.
   - A payment of $5,000 will be made upon successful completion of Milestones I, II and III and Newport News Shipbuilding's receipt of proper invoice.
4. Milestone IV – Within twenty four (24) weeks after receipt of purchase order, the vendor will have incorporated agreed upon changes (based on input from Prototype demo) and shipped the unit to NNS for Welding Lab and Production evaluations.

5. Milestone V – Within thirty (30) weeks after receipt of purchase order, NNS will return the torch attachments to the vendor for: their evaluation of wear, overheating, and deterioration; minor modifications/repair of any deficiencies that were found during the Production Evaluation; and refurbishment for return to NNS for evaluation by the other NSRP Shipyards.
   - A payment of $2,000 will be made upon successful completion

   of Milestones IV and V and Newport Shipbuilding receipt of a proper invoice.

- The timetables listed above are crucial to the successful completion of this project. Any unfavorable variances in designated Milestones will adversely affect the remaining Milestones in other portions of the project.
- Any resulting purchase order will be awarded to the vendor submitting the offer which is the most advantageous to the purchaser, price and other factors considered. Other factors in order of importance shall include: NNS Quality Rating of Vendor, delivery, technical competence, the financial stability of the supplier, production capacity and impact of this award on operations, management capabilities/support and cost controls.

DESCRIPTION

Item Qty Description

1 3 pcs. Torch Attachment- Semi-Auto Welding

Description : Develop and construct a durable, lightweight semi-automatic welding torch attachment that can be used for GMAW-SA, GMAW-S, GMAW-P and FCAW. Attachment to the torch and removal shall be easily performed by the operator and require minimum maintenance. It shall meet the following performance specifications and operating characteristics:

A. Easily attachable and detachable to the semi-automatic torch.
B. Maintain a pre-setable torch angle and/or tip-to-work distance.
C. Attach to the torch and maintain a pre-setable travel speed.
D. Travel speed ranges should be for travel wire sizes: .035 , .045 & .052" solid; .035, .045, .052 & 1/16" flux-cored.
E. Duty cycle: 60% (six minutes out of ten) with mixed argon gases (greater than 75% argon).
F. The complete torch attachment with the above attributes shall: enhance the operators ability to produce a defect free weld; provide good welding arc visibility; produce minimal heat discomfort to the operator's hands; be ergonomically balanced to minimize fatigue.

2 3 pcs Manual

Description : One operator and maintenance manual per torch attachment Shall include exploded view of replacement parts with recommended spares and listing of manufacturer part numbers.

SEMI-AUTOMATIC WELDING TORCH LABORATORY EVALUATION SUMMARY

(NSRP Project #7-96-6)

TORCH MANUFACTURER - DovaTech-Bernard Welding Equipment Co. **MODEL - Prototype** Date: 2/28/00

Weld Processes: FCAW/GMAW-Spray & Pulsed

ATTRIBUTES **Torch Max Operating Range: 325 to 350 Amps @ 28-30 volts** **Wire Sizes: .035, .045, .052 solid & .035, .045, .052 & 1/16" FCAW** **Duty Cycle: 60% (6 minutes out of 10 with mixed gases;>75% argon)**	**Yes, No or Rating**	**COMMENTS**
1. Does the torch operate satisfactorily at the rated welding amperage, voltage and duty cycle?	Yes	Tests were performed with parameters and wire diameters at maximum ranges. Duty cycle testing was performed in sets of three (6 min. on / 4 min off; 6 min. on / 4 min off; 6 min. on / 4 min off)
2. Do the consumables, i.e. nozzle/tip hold up at the above conditions?	Yes, with alternate setup	The contact tip became loose and would not stay in diffuser at maximum rated duty cycle. Vendor submitted different front end and no problems were encountered. Operation was satisfactory at rated operational ranges.
3. Rate the contact tip design based on installation & removal: unsatisfactory; fair; very good; excellent.	Fair	The evaluators had problems installing the elliptical contact tip so it would remain secure. Some tip installation problems also surfaced with spatter on the diffuser and slight burrs on contact tips. Most welders only have long nose pliers for tip & nozzle removal and cleaning.
4. Rate the nozzle/cup design based on installation, removal & spatter removal: un-satisfactory; fair; very good; excellent.	Fair	Installation, removal, and cleaning of nozzle/cup was very simple and straight forward. First nozzle did not seat well. Second setup satisfactory.
5. Rate the overall gas coverage/diffuser design based on most critical process/condition: unsatisfactory; fair; very good; excellent.	Very Good	
6. Rate the overall gas coverage compared to torches currently being used by the operator: not equal; equal to; better than; much better than.	Equal to (satisfactory)	
7. Rate the wire feedability based on normal process/conditions: unsatisfactory; fair; very good; excellent.	Very Good	
8. Is the handle temperature at the rated duty cycle/parameters comfortable?	Yes	Handle remained cool enough to handle with bare hand after welding
9. Is the operator's hand sufficient distance away from the welding arc?	Yes	
10. Rate the comfort of the handle: unsatisfactory; fair; very good; excellent.	Excellent	
11. Is the torch ergonomically balanced to minimize fatigue?	Yes	
12. Rate the comfort of the torch trigger: unsatisfactory; fair; very good; excellent.	Very Good	A "locking type trigger" would be a desirable feature
13. Rate the torch cables based on flexibility & weight: unsatisfactory; fair; very good; excellent.	Excellent	Extremely lightweight for the welding amperage capability
14. Rate the overall torch based on operability, operator appeal, flexibility & weight compared to torches currently being used and others being tested: not equal; equal to; better than; much better than.	Very Good	Torch performed to specifications

Table V

SEMI-AUTOMATIC WELDING TORCH LABORATORY EVALUATION SUMMARY

(NSRP Project #7-96-6)

TORCH MANUFACTURER - OXO Welding Equipment Co. **MODEL - Prototype** Date: 2/28/00

Weld Processes: FCAW/GMAW-Spray & Pulsed

ATTRIBUTES **Torch Max Operating Range: 325 to 350 Amps @ 28-30 volts** **Processes: GMAW-S, GMAW-P, FCAW** **Wire Sizes: .035, .045, .052 solid & .035, .045, .052 & 1/16" FCAW** **Duty Cycle: 60% (6 minutes out of 10 with mixed gases;>75% argon)**	**Yes, No or Rating**	**COMMENTS**
1. Does the torch operate satisfactorily at the rated welding amperage, voltage and duty cycle?	Yes	Tests were performed with parameters and wire diameters in the maximum ranges. Duty cycle testing were performed in sets of three (6 min. on / 4 min off; 6 min. on / 4 min off; 6 min. on / 4 min off)
2. Do the consumables, i.e. nozzle/tip hold up at the above conditions?	Yes	Problems encountered with tip seizing at maximum rated duty cycle. Vendor recommended usage of upper ID ranges of tips (.059vs.055" & .078vs.071") specs. Larger ID tips performed satisfactory at rated operational ranges.
3. Rate the contact tip design based on installation & removal: unsatisfactory; fair; very good; excellent.	Good	Ability to install and remove contact tip was good except when burn-back occurred. Most welders only have long nose pliers. Some problems turning threads completely out with solid wire
4. Rate the nozzle/cup design based on installation, removal & spatter removal: unsatisfactory; fair; very good; excellent.	Very Good	Installation, removal, and cleaning of nozzle/cup was very simple and straight forward
5. Rate the overall gas coverage/diffuser design based on most critical process/condition: unsatisfactory; fair; very good; excellent.	Very Good	
6. Rate the overall gas coverage compared to torches currently being used by the operator: not equal; equal to; better than; much better than.	Equal to (satisfactory)	
7. Rate the wire feedability based on normal process/conditions: unsatisfactory; fair; very good; excellent.	Very Good	
8. Is the handle temperature at the rated duty cycle/parameters comfortable?	Yes	Prototype I too hot to handle. Prototype II fairly cool for gloved hand.
9. Is the operator's hand sufficient distance away from the welding arc?	Yes	
10. Rate the comfort of the handle: unsatisfactory; fair; very good; excellent.	Excellent	
11. Is the torch ergonomically balanced to minimize fatigue?	Yes	
12. Rate the comfort of the torch trigger: unsat.; fair; very good; excellent.	Excellent	Locking trigger very valuable asset
13. Rate the torch cables based on flexibility & weight: unsatisfactory; fair; very good; excellent.	Very Good	
14. Rate the overall torch based on operability, operator appeal, flexibility & weight compared to torches currently being used and others being tested: not equal; equal to; better than; much better than.	Very Good	Torch performed to specifications

Table VI

SEMI-AUTOMATIC WELDING TORCH LABORATORY EVALUATION SUMMARY

(NSRP Project #7-96-6)

TORCH MANUFACTURER - Tweco **MODEL - Prototype** Date: 2/28/00

Weld Processes: FCAW/GMAW-Spray /Pulsed

ATTRIBUTES **Torch Max Operating Range: 325 to 350 Amps @ 28-30 volts** **Processes: GMAW-S, GMAW-P, FCAW** **Wire Sizes: .035, .045, .052 solid & .035, .045, .052 & 1/16" FCAW** **Duty Cycle: 60% (6 minutes out of 10 with mixed gases;>75% argon)**	**Yes, No or Rating**	**COMMENTS**
1. Does the torch operate satisfactorily at the rated welding amperage, voltage and duty cycle?	Yes	Tests were performed with parameters and wire diameters in the maximum ranges. Duty cycle testing were performed in sets of three (6 min. on / 4 min off; 6 min. on/ 4 min off; 6 min. on/ 4 min off)
2. Do the consumables, i.e. nozzle/tip hold up at the above conditions?	Yes	Nozzle/tips performed very well at rated operational ranges
3. Rate the contact tip design based on installation & removal: unsatisfactory; fair; very good; excellent.	Excellent	Ability to install and remove contact tip was very user friendly. Basically did not require any tools.
4. Rate the nozzle/cup design based on installation, removal & spatter removal: unsatisfactory; fair; very good; excellent.	Excellent	Installation, removal, and cleaning of nozzle/cup was very simple and straight forward
5. Rate the overall gas coverage/diffuser design based on most critical process/condition: unsatisfactory; fair; very good; excellent.	Fair	RT of several GMAW-S joints had indications of minor porosity. Investigations revealed marginal gas flow capabilities with prototype.
6. Rate the overall gas coverage compared to torches currently being used by the operator: not equal; equal to; better than; much better than.	Equal to (satisfactory)	
7. Rate the wire feedability based on normal process/conditions: unsatisfactory; fair; very good; excellent.	Very Good	
8. Is the handle temperature at the rated duty cycle/parameters comfortable?	Yes	Torch remained cool enough to handle with bare hand.
9. Is the operator's hand sufficient distance away from the welding arc?	Yes	
10. Rate the comfort of the handle: unsatisfactory; fair; very good; excellent.	Excellent	
11. Is the torch ergonomically balanced to minimize fatigue?	Yes	
12. Rate the comfort of the torch trigger: unsatisfactory; fair; very good; excellent.	Good	Locking trigger needs to be added.
13. Rate the torch cables based on flexibility & weight: unsatisfactory; fair; very good; excellent.	Excellent	
14. Rate the overall torch based on operability, operator appeal, flexibility & weight compared to torches currently being used and others being tested: not equal; equal to; better than; much better than.	Very Good	Torch performed to specifications

Table VII

PRODUCTION EVALUATION RESPONSE SUMMARY – ALL TORCH TYPES

(Data Based On Input From Seven Major Shipyards)

Survey Question		Yes		No		Un-Sat or Not Equal		Fair or Equal To		Very Good or Better		Excellent Better Than	
		PERCENTAGES BASED ON WEIGHTED & UN-WEIGHTED AVERAGES											
	Torch Manu'f	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt
1. Does the torch operate satisfactorily at the rated welding amperage, voltage and duty cycle?	DovaTech	**96**	**89**	**4**	**11**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	OXO	**99**	**96**	**1**	**4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Tweco	**92**	**98**	**8**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
2. Do the consumables, i.e. nozzle/tip hold up at the above conditions?	DovaTech	**73**	**80**	**27**	**20**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	OXO	**96**	**86**	**4**	**14**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Tweco	**88**	**84**	**12**	**16**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
3. Rate the contact tip design based on installation & removal.	DovaTech	**-**	**-**	**-**	**-**	**38**	**48**	**41**	**37**	**21**	**15**	**-**	**-**
	OXO	**-**	**-**	**-**	**-**	**1**	**6**	**16**	**48**	**50**	**37**	**33**	**11**
	Tweco	**-**	**-**	**-**	**-**	**25**	**50**	**41**	**29**	**32**	**12**	**2**	**9**
4. Rate the nozzle/cup design based on installation, removal & spatter removal.	DovaTech	**-**	**-**	**-**	**-**	**34**	**52**	**33**	**26**	**33**	**22**	**-**	**-**
	OXO	**-**	**-**	**-**	**-**	**4**	**23**	**21**	**29**	**40**	**34**	**35**	**14**
	Tweco	**-**	**-**	**-**	**-**	**20**	**32**	**33**	**26**	**44**	**26**	**3**	**15**
5. Rate the overall gas coverage/ diffuser design based on most critical process/condition.	DovaTech	**-**	**-**	**-**	**-**	**5**	**4**	**48**	**65**	**43**	**27**	**5**	**4**
	OXO	**-**	**-**	**-**	**-**	**-**	**-**	**15**	**46**	**52**	**34**	**33**	**20**
	Tweco	**-**	**-**	**-**	**-**	**1**	**7**	**21**	**40**	**51**	**30**	**26**	**23**
6. Rate the overall gas coverage compared to torches currently being used by the operator.	DovaTech	**-**	**-**	**-**	**-**	**3**	**12**	**73**	**69**	**24**	**19**	**-**	**-**
	OXO	**-**	**-**	**-**	**-**	**1**	**6**	**83**	**71**	**9**	**20**	**7**	**3**
	Tweco	**-**	**-**	**-**	**-**	**2**	**10**	**70**	**57**	**26**	**20**	**3**	**13**
7. Rate the wire feedability based on normal process/conditions.	DovaTech	**-**	**-**	**-**	**-**	**2**	**8**	**15**	**46**	**55**	**35**	**29**	**12**
	OXO	**-**	**-**	**-**	**-**	**1**	**6**	**11**	**35**	**66**	**44**	**21**	**15**
	Tweco	**-**	**-**	**-**	**-**	**22**	**10**	**5**	**27**	**45**	**33**	**28**	**30**
8. Is the handle temperature at the rated duty cycle/ parameters comfortable?	DovaTech	**91**	**70**	**9**	**27**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
	OXO	**95**	**77**	**5**	**17**	**-**	**-**	**-**	**6**	**-**	**-**	**-**	**-**
	Tweco	**98**	**90**	**2**	**7**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**

Table VIII

PRODUCTION EVALUATION RESPONSE SUMMARY – ALL TORCH TYPES

(Data Based On Input From Seven Major Shipyards)

Survey Question		Yes		No		Un-Sat or Not Equal		Fair or Equal To		Very Good or Better		Excellent Better Than	
		PERCENTAGES BASED ON WEIGHTED & UN-WEIGHTED AVERAGES											
	Torch Manu'f	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt	Wgt'd	Un-Wgt
9. Is the operators hand sufficient distance away from the welding arc?	DovaTech	**98**	**94**	**2**	**6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	OXO	**97**	**88**	**3**	**10**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**
	Tweco	**98**	**90**	**2**	**7**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**
10. Rate the comfort of the handle.	DovaTech	**-**	**-**	**-**	**-**	**33**	**52**	**17**	**30**	**50**	**19**	**-**	**-**
	OXO	**-**	**-**	**-**	**-**	**7**	**34**	**25**	**26**	**46**	**29**	**23**	**11**
	Tweco	**-**	**-**	**-**	**-**	**15**	**38**	**25**	**24**	**57**	**26**	**3**	**12**
11. Is the torch ergonomically balanced to minimize fatigue?	DovaTech	**55**	**40**	**45**	**57**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	OXO	**72**	**57**	**28**	**35**	**-**	**-**	**-**	**4**	**-**	**4**	**-**	**-**
	Tweco	**81**	**52**	**19**	**31**	**-**	**-**	**-**	**10**	**-**	**5**	**-**	**2**
12. Rate the trigger feel/comfort.	DovaTech	**-**	**-**	**-**	**-**	**10**	**42**	**19**	**23**	**71**	**35**	**-**	**-**
	OXO	**-**	**-**	**-**	**-**	**3**	**17**	**17**	**40**	**38**	**29**	**42**	**14**
	Tweco	**-**	**-**	**-**	**-**	**32**	**42**	**10**	**18**	**39**	**18**	**18**	**21**
13. Rate the torch cables based on flexibility & weight.	DovaTech	**-**	**-**	**-**	**-**	**18**	**42**	**13**	**31**	**62**	**23**	**7**	**4**
	OXO	**-**	**-**	**-**	**-**	**24**	**36**	**53**	**47**	**15**	**8**	**8**	**8**
	Tweco	**-**	**-**	**-**	**-**	**11**	**32**	**37**	**29**	**50**	**26**	**3**	**13**
14. Rate the overall torch on operability, operator appeal, flexibility & weight compared to torches currently being used and others tested.	DovaTech	**-**	**-**	**-**	**-**	**63**	**77**	**7**	**4**	**29**	**19**	**0**	**-**
	OXO	**-**	**-**	**-**	**-**	**47**	**61**	**30**	**26**	**22**	**11**	**1**	**3**
	Tweco	**-**	**-**	**-**	**-**	**45**	**58**	**36**	**16**	**15**	**10**	**4**	**16**

Table VIII

Semi-Automatic Welding Torch Evaluation Summary - DovaTech

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
1. Does the torch operate satisfactorily at the rated welding amperage, voltage and duty cycle?	**88%**	**12%**				
Comments:						
2. Do the consumables, i.e. nozzle/tip hold up at the above conditions?	**82%**	**18%**				
Comments: ❑ Based on feedback they held up at the amperages used during the evaluation						
3. Rate the contact tip design based on installation & removal.			**44%**	**41%**	**15%**	
Comments: ❑ Tip difficult to adjust for proper stick-out, should bottom out with 1/8” recess ❑ Tip difficult to remove & install due to spatter adhering to diffuser ❑ Some Shipyards prefer threaded contact tips ❑ Contact tip performance was surprisingly good after learning that it must cool down before removing. ❑ Difficult to get comfortable with offset lock						
4. Rate the nozzle/cup design based on installation, removal & spatter removal.			**50%**	**27%**	**23%**	
Comments: ❑ Nozzle assembly too large, complicated, and comes off too easy ❑ Slag adhered to diffuser & tip made it difficult for tip removal and installation ❑ Too much weight on front end; too bulky, ten times bigger than necessary						
5. Rate the overall gas coverage/diffuser design based on most critical process/condition.			**4%**	**64%**	**28%**	**4%**
Comments:						
6. Rate the overall gas coverage compared to torches currently being used by the operator.			**12%**	**68%**	**20%**	
Comments:						

Table IX

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
7. Rate the wire feedability based on normal process/conditions.			**8%**	**48%**	**36%**	**8%**
Comments:						
8. Is the handle temperature at the rated duty cycle/parameters comfortable?	**69%**	**23%**	**3%**			
Comments:						
9. Is the operator's hand sufficient distance away from the welding arc?	**94%**	**6%**				
Comments:						
10. Rate the comfort of the handle.			**54%**	**31%**	**15%**	
Comments:						
11. Is the torch ergonomically balanced to minimize fatigue?	**39%**	**61%**				
Comments:						
12. Rate the torch trigger feel/comfort.			**44%**	**24%**	**32%**	
Comments: ❑ Not large enough, difficult to feel with gloved hand ❑ A locking type trigger is needed for many applications						
13. Rate the torch cables based on flexibility & weight.			**44%**	**32%**	**20%**	**4%**
Comments: ❑ Cable too heavy for out-of-position work ❑ Torch cable was very flexible and performs superior to the other torches evaluated.						
14. Rate the overall torch based on operability, operator appeal, flexibility & weight compared to torches currently being used and others being tested.			**76%**	**4%**	**20%**	

Table IX

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To

Comments:

- The torch neck needs to be insulated by an outer jacket, netting or mesh. When welding in vertical & overhead positions, spatter often collects between the diffuser/tip and cup thereby when the neck body accidentally contacts the work it will short out.
- The swivel neck is a good option but should require a wrench to ensure sufficient torque. This would prevent flopping of neck. Some welders would not tighten the securing nut sufficiently to prevent overheating. It should be noted that when each torch was inspected after the evaluation period, all swivel neck could be moved easily by hand. This condition was common to all manufacturers' torches tested.

NOTE : The comments noted above were consolidated from the individual "Evaluation forms" and do not necessarily represent the consensus opinion of all those that participated in the "Production Evaluation". Some were single comments while others were repeatedly noted throughout the evaluation spectrum.

The response percentages by each evaluation category represent the consensus of those welders surveyed during the Production Evaluation from the SP-7 Shipyards participating in this project.

Semi-Automatic Welding Torch Evaluation Summary - OXO

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
1. Does the torch operate satisfactorily at the rated welding amperage, voltage and duty cycle?	**96%**	**4%**				
Comments: ❑ Not good at upper amperage range ❑ Torch neck seems too long for the handle, needs to have more of an angle						
2. Do the consumables, i.e. nozzle/tip hold up at the above conditions?	**86%**	**14%**				
Comments: ❑ Tip works very well, easy to remove ❑ Spatter builds up too easy on diffuser						
3. Rate the contact tip design based on installation & removal.			**6%**	**47%**	**38%**	**9%**
Comments:						
4. Rate the nozzle/cup design based on installation, removal & spatter removal.			**24%**	**29%**	**35%**	**12%**
Comments: ❑ Doesn't hold up in mid to upper welding ranges ❑ Spatter gets down in nozzle making it difficult to remove ❑ Brass diffuser enhances spatter build up						
5. Rate the overall gas coverage/diffuser design based on most critical process/condition.				**47%**	**35%**	**18%**
Comments: ❑ The gas diffuser un-screwed from the neck when nozzle assembly seized due to heating						
6. Rate the overall gas coverage compared to torches currently being used by the operator.			**6%**	**71%**	**21%**	**3%**
Comments: ❑ Gas coverage not good in the wind						

Table X

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
7. Rate the wire feedability based on normal process/conditions.			**6%**	**36%**	**45%**	**12%**
Comments:						
8. Is the handle temperature at the rated duty cycle/parameters comfortable?	**77%**	**17%**		**6%**		
Comments: ❑ The handle has exposed screws that collect spatter making it difficult to perform maintenance						
9. Is the operator's hand sufficient distance away from the welding arc?	**87%**	**11%**		**2%**		
Comments:						
10. Rate the comfort of the handle.			**35%**	**24%**	**29%**	**12%**
Comments:						
11. Is the torch ergonomically balanced to minimize fatigue?	**56%**	**35%**		**4%**	**4%**	
Comments: ❑ The large cable and small handle make it unbalanced for the user						
12. Rate the torch trigger feel/comfort.			**18%**	**41%**	**29%**	**12%**
Comments: ❑ Trigger difficult to find with gloves, too small ❑ Great location for trigger lock, work very well						

Table X

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
13. Rate the torch cables based on flexibility & weight.			**37%**	**46%**	**9%**	**9%**
Comments: ❑ Cable heavy and not flexible for use with small diameter wires ❑ Cable stiff at base of torch handle causing strain to wrist and arm						
14. Rate the overall torch based on operability, operator appeal, flexibility & weight compared to torches currently being used and others being tested.			**62%**	**24%**	**11%**	**3%**
Comments: ❑ Good design overall, needs some front end changes to hold up at the upper parameter ranges ❑ Torch handle is great but the cable is too large, heavy, and stiff ❑ The swivel neck is a good option but should require a wrench to ensure sufficient torque. This would prevent flopping of neck.						

NOTE: The comments noted above were consolidated from the individual "Evaluation forms" and do not necessarily represent the consensus opinion of all those that participated in the "Production Evaluation". Some were single comments while others were repeatedly noted throughout the evaluation spectrum.

The response percentages by each evaluation category represent the consensus of those welders surveyed during the Production Evaluation from the SP-7 Shipyards participating in this project.

Semi-Automatic Welding Torch Evaluation Summary - Tweco

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
1. Does the torch operate satisfactorily at the rated welding amperage, voltage and duty cycle?	**98%**	**2%**				
Comments: ❑ Tip gets hot at rated amperage						
2. Do the consumables, i.e. nozzle/tip hold up at the above conditions?	**83%**	**17%**				
Comments: ❑ Easy tip removal ❑ Excessive spatter build up						
3. Rate the contact tip design based on installation & removal.			**52%**	**27%**	**12%**	**9%**
Comments: ❑ When tip is hot it is hard to remove						
4. Rate the nozzle/cup design based on installation, removal & spatter removal.			**33%**	**24%**	**27%**	**15%**
Comments: ❑ Cup & locking assembly seizes together when hot ❑ Cup does not secure good to locking assembly, not enough threads ❑ Two part assembly great idea						
5. Rate the overall gas coverage/diffuser design based on most critical process/condition.			**7%**	**41%**	**28%**	**24%**
Comments: ❑ Gas diffuser seized to gas cup ❑ Gas coverage not good in the wind						
6. Rate the overall gas coverage compared to torches currently being used by the operator.			**10%**	**55%**	**21%**	**14%**
Comments:						

Table XI

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
7. Rate the wire feedability based on normal process/conditions.			**10%**	**28%**	**34%**	**28%**
Comments: ❑						
8. Is the handle temperature at the rated duty cycle/parameters comfortable?	**91%**	**7%**		**2%**		
Comments: ❑						
9. Is the operator's hand sufficient distance away from the welding arc?	**91%**	**7%**		**2%**		
Comments: ❑						
10. Rate the comfort of the handle.			**39%**	**24%**	**24%**	**12%**
Comments: ❑ Curvature of handle forced wrist in awkward position, design not comfortable on long weld lengths ❑ Uncomfortable unless torch neck was swiveled ❑ Very light						
11. Is the torch ergonomically balanced to minimize fatigue?	**51%**	**32%**		**10%**	**5%**	**2%**
Comments: ❑						
12. Rate the torch trigger feel/comfort.			**44%**	**19%**	**19%**	**18%**
Comments: ❑ Trigger sometimes hard to find with gloves on; not big enough ❑ Too skinny, short, and sensitive need better locking device ❑ Trigger needs a small lip (90 degree) on lever end to improve feel and make easier to energize ❑ Locking device sticks; to fragile and cumbersome to operate						

Table XI

Survey Question	Yes	No	Un-Sat or Not Equal To	Fair or Equal To	Very Good or Equal To	Excellent or Equal To
13. Rate the torch cables based on flexibility & weight.			**33%**	**30%**	**23%**	**13%**
Comments: ❑ Not flexible enough and too heavy ❑ Cable stiff at the gun						
14. Rate the overall torch based on operability, operator appeal, flexibility & weight compared to torches currently being used and others being tested.			**60%**	**13%**	**10%**	**17%**
Comments: ❑ The torch goose-neck flops around too easily, when hand tightened it becomes loose						

NOTE: The comments noted above were consolidated from the individual "Evaluation forms" and do not necessarily represent the consensus opinion of all those that participated in the "Production Evaluation". Some were single comments while others were repeatedly noted throughout the evaluation spectrum.

The response percentages by each evaluation category represent the consensus of those welders surveyed during the Production Evaluation from the SP-7 Shipyards participating in this project.

Table XI

BUG-O/Weld Tooling

Conceptual Torch Attachment Design

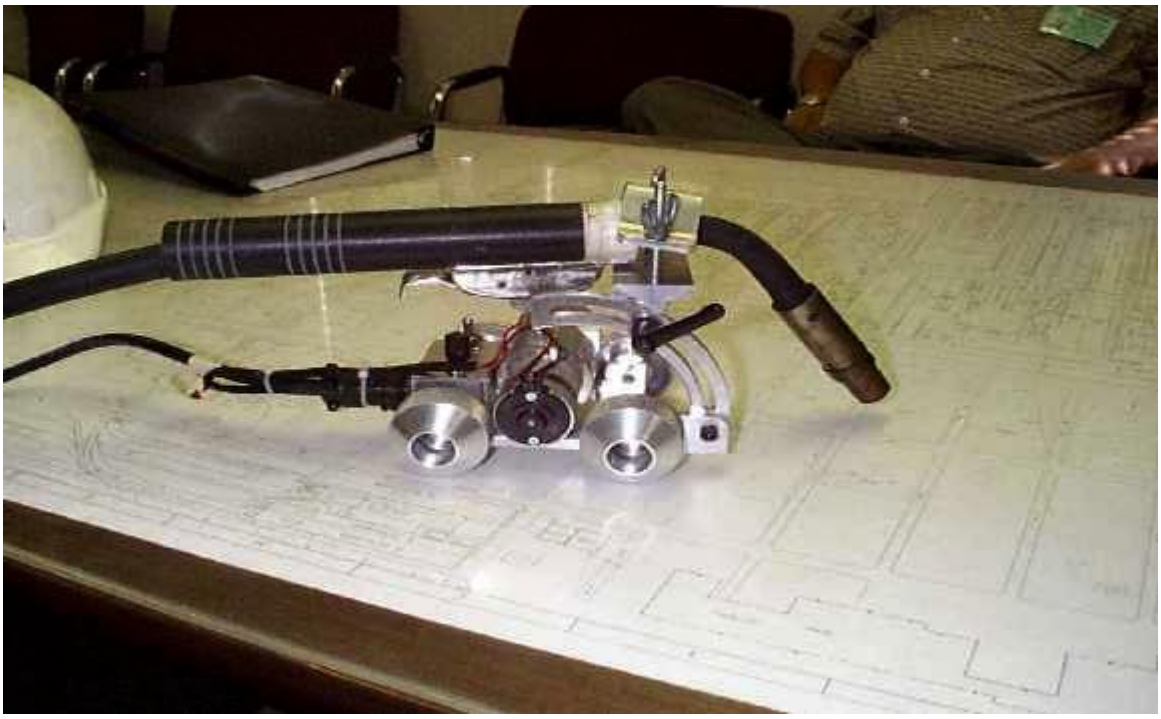

Figure 1

Kroll Industries

Conceptual Torch Attachment Design

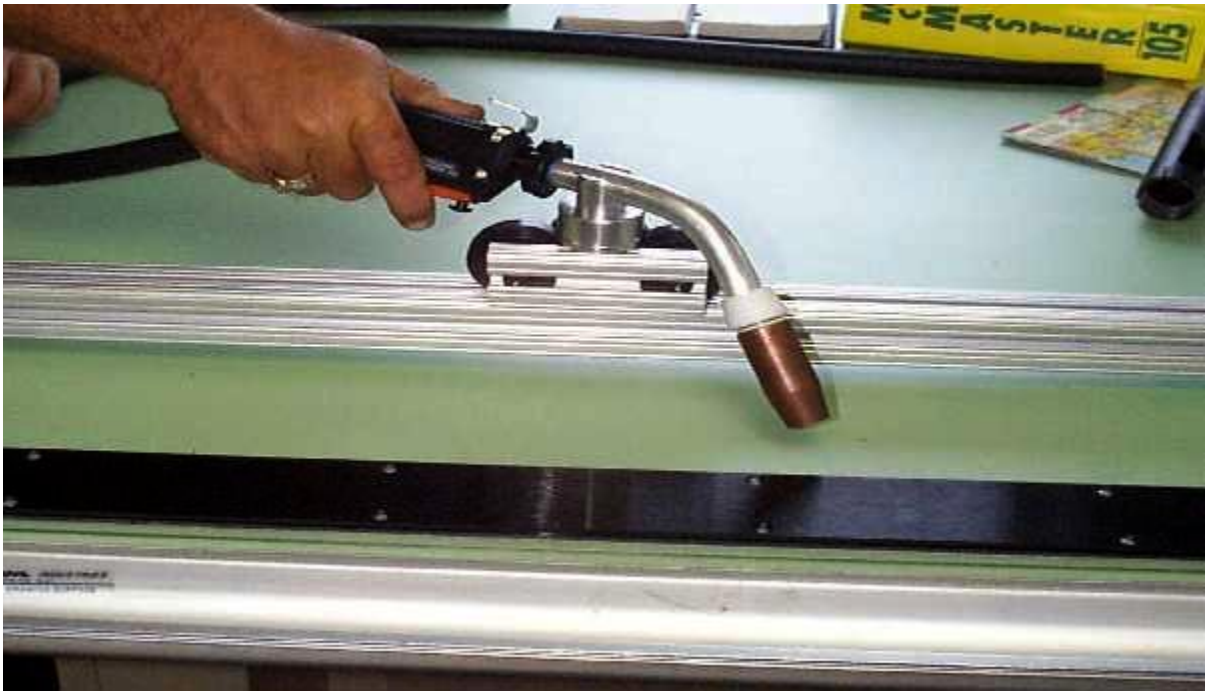

Figure 2

For more information about the
National Shipbuilding Research Program
please visit:

http://www.nsrp.org/

or

http://www.USAShipbuilding.com/